PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 14 November 2000 (14.11.00)	
International application No. PCT/DK00/00094	**Applicant's or agent's file reference** P199900311 WO
International filing date (day/month/year) 07 March 2000 (07.03.00)	**Priority date** (day/month/year) 08 March 1999 (08.03.99)
Applicant NIELSEN, Evan	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

02 October 2000 (02.10.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Nestor Santesso
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

MIR/LBW

RECORD COPY

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/DK 00/00094

International Filing Date 07 MARCH 2000

Name of receiving Office and "PCT International Application" Danish Patent and Trademark Office PCT-International Application

Applicant's or agent's file reference *(if desired) (12 characters maximum)* P199900311 WO

Box No. I TITLE OF INVENTION

A method and an apparatus for measuring icing

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

NIELSEN, Evan
Holmevej 35
DK-9640 Farsø
DENMARK

[x] This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: DK Denmark

State *(that is, country)* of residence: DK Denmark

This person is applicant for the purposes of: [x] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:

[ ] applicant only

[ ] applicant and inventor

[ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

[ ] Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: [x] agent [ ] common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Hofman-Bang A/S
Hans Bekkevolds Allé 7
DK-2900 Hellerup
DENMARK

Telephone No. +45 39 48 80 00

Facsimile No. +45 39 48 80 80

Teleprinter No. 19 085 hbb dk

[ ] **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- ☒ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **TZ** United Republic of Tanzania, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- ☒ **AE** United Arab Emirates
- ☒ **AL** Albania
- ☒ **AM** Armenia
- ☒ **AT** Austria ... and Utility Model
- ☒ **AU** Australia
- ☒ **AZ** Azerbaijan
- ☒ **BA** Bosnia and Herzegovina
- ☒ **BB** Barbados
- ☒ **BG** Bulgaria
- ☒ **BR** Brazil
- ☒ **BY** Belarus
- ☒ **CA** Canada
- ☒ **CH and LI** Switzerland and Liechtenstein
- ☒ **CN** China
- ☒ **CR** Costa Rica
- ☒ **CU** Cuba
- ☒ **CZ** Czech Republic ... and Utility Model
- ☒ **DE** Germany ... and Utility Model
- ☒ **DK** Denmark ... and Utility Model
- ☒ **DM** Dominica
- ☒ **EE** Estonia ... and Utility Model
- ☒ **ES** Spain
- ☒ **FI** Finland ... and Utility Model
- ☒ **GB** United Kingdom
- ☒ **GD** Grenada
- ☒ **GE** Georgia
- ☒ **GH** Ghana
- ☒ **GM** Gambia
- ☒ **HR** Croatia
- ☒ **HU** Hungary
- ☒ **ID** Indonesia
- ☒ **IL** Israel
- ☒ **IN** India
- ☒ **IS** Iceland
- ☒ **JP** Japan
- ☒ **KE** Kenya
- ☒ **KG** Kyrgyzstan
- ☒ **KP** Democratic People's Republic of Korea
- ☒ **KR** Republic of Korea
- ☒ **KZ** Kazakhstan
- ☒ **LC** Saint Lucia
- ☒ **LK** Sri Lanka
- ☒ **LR** Liberia
- ☒ **LS** Lesotho
- ☒ **LT** Lithuania
- ☒ **LU** Luxembourg
- ☒ **LV** Latvia
- ☒ **MA** Morocco
- ☒ **MD** Republic of Moldova
- ☒ **MG** Madagascar
- ☒ **MK** The former Yugoslav Republic of Macedonia
- ☒ **MN** Mongolia
- ☒ **MW** Malawi
- ☒ **MX** Mexico
- ☒ **NO** Norway
- ☒ **NZ** New Zealand
- ☒ **PL** Poland
- ☒ **PT** Portugal
- ☒ **RO** Romania
- ☒ **RU** Russian Federation
- ☒ **SD** Sudan
- ☒ **SE** Sweden
- ☒ **SG** Singapore
- ☒ **SI** Slovenia
- ☒ **SK** Slovakia ... and Utility Model
- ☒ **SL** Sierra Leone
- ☒ **TJ** Tajikistan
- ☒ **TM** Turkmenistan
- ☒ **TR** Turkey
- ☒ **TT** Trinidad and Tobago
- ☒ **TZ** United Republic of Tanzania
- ☒ **UA** Ukraine
- ☒ **UG** Uganda
- ☒ **US** United States of America
- ☒ **UZ** Uzbekistan
- ☒ **VN** Viet Nam
- ☒ **YU** Yugoslavia
- ☒ **ZA** South Africa
- ☒ **ZW** Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☐ .....
- ☐ .....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

PCT/DK00/00094

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 08.03.1999	PA199900323	Denmark		
item (2)			✓	
item (3)				

RO/DK 7 MARCH 2000

☐ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): _____

** Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*
ISA/EP

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date (day/month/year)	Number	Country (or regional Office)
11 March 1999	DK 99/00017	Denmark

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request	:	3
description (excluding sequence listing part)	:	18
claims	:	6
abstract	:	1
drawings	:	8
sequence listing part of description	:	
Total number of sheets	:	36

This international application is **accompanied** by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☒ priority document(s) identified in Box No. VI as item(s): 1
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify)*: DK 99/00017

Figure of the drawings which should accompany the abstract: 9

Language of filing of the international application: Danish

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Evan Nielsen

For receiving Office use only

1. Date of actual receipt of the purported international application: RO/DK 7 MARCH 2000 (07.03.2000)
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/EPO
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 28 MARCH 2000 (28.03.00)

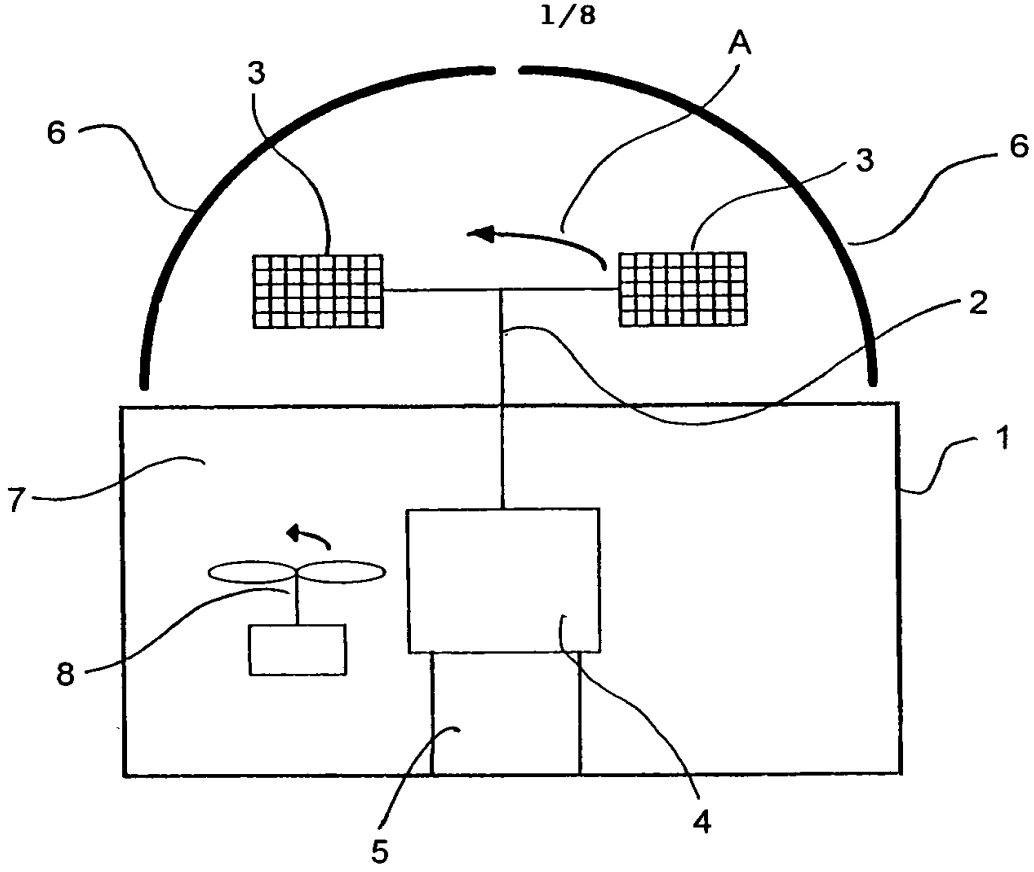


Fig. 1

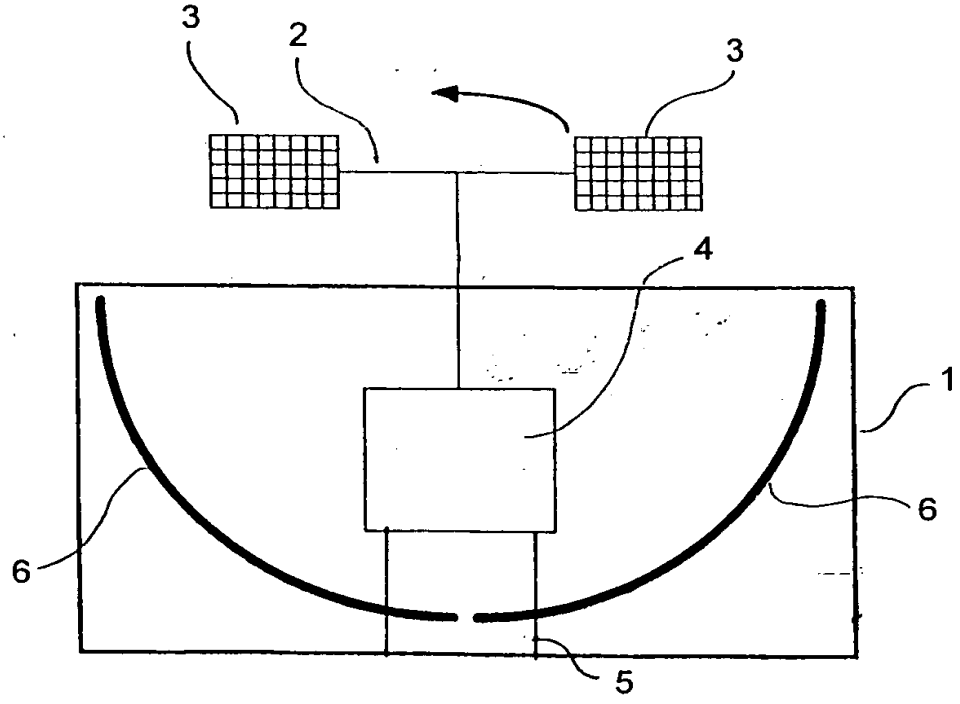


Fig. 2

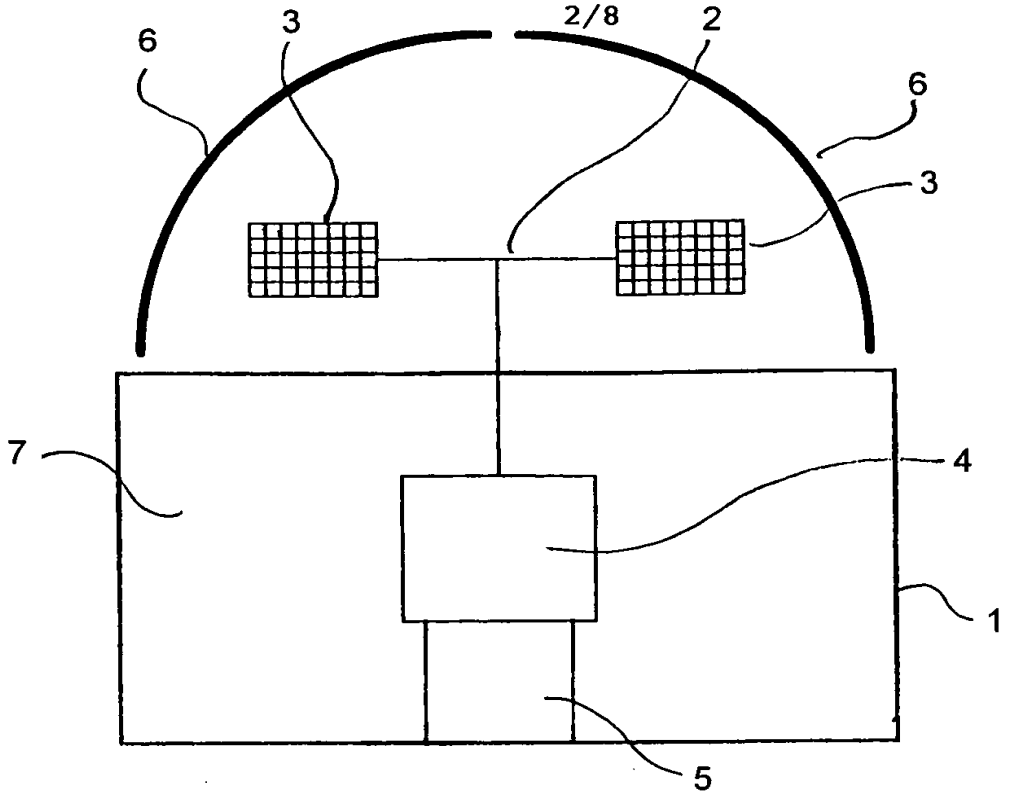


Fig. 3

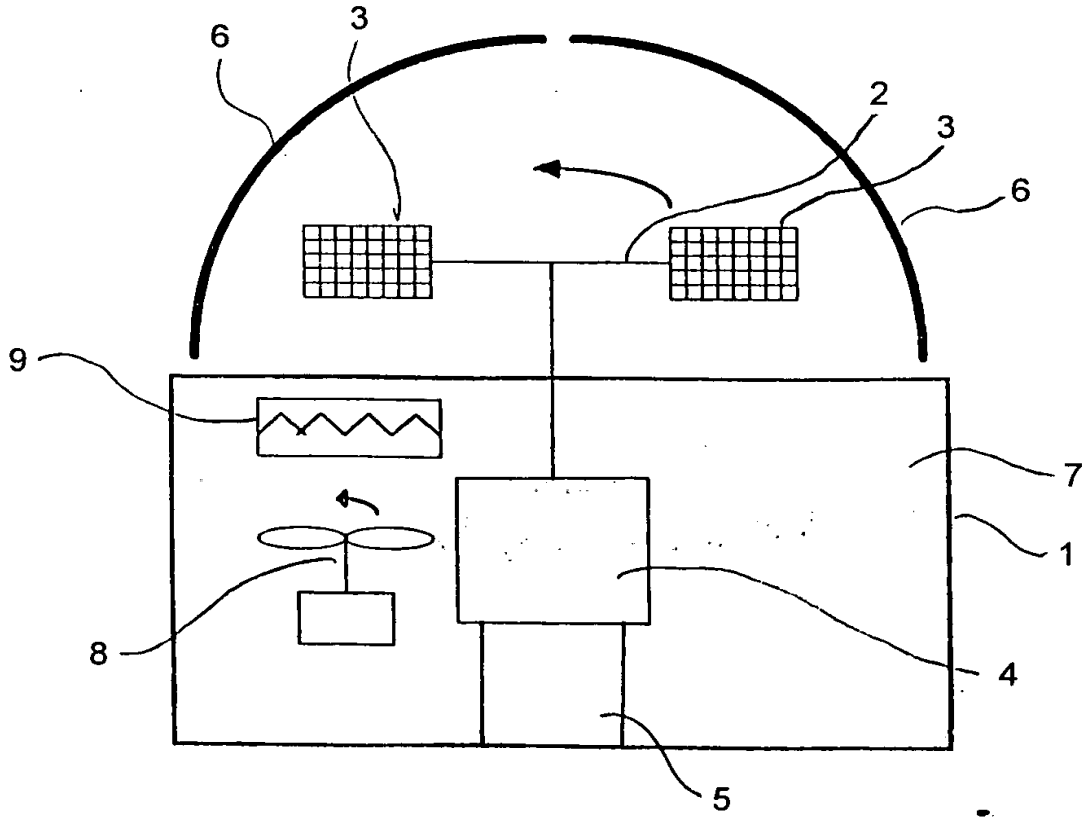


Fig. 4

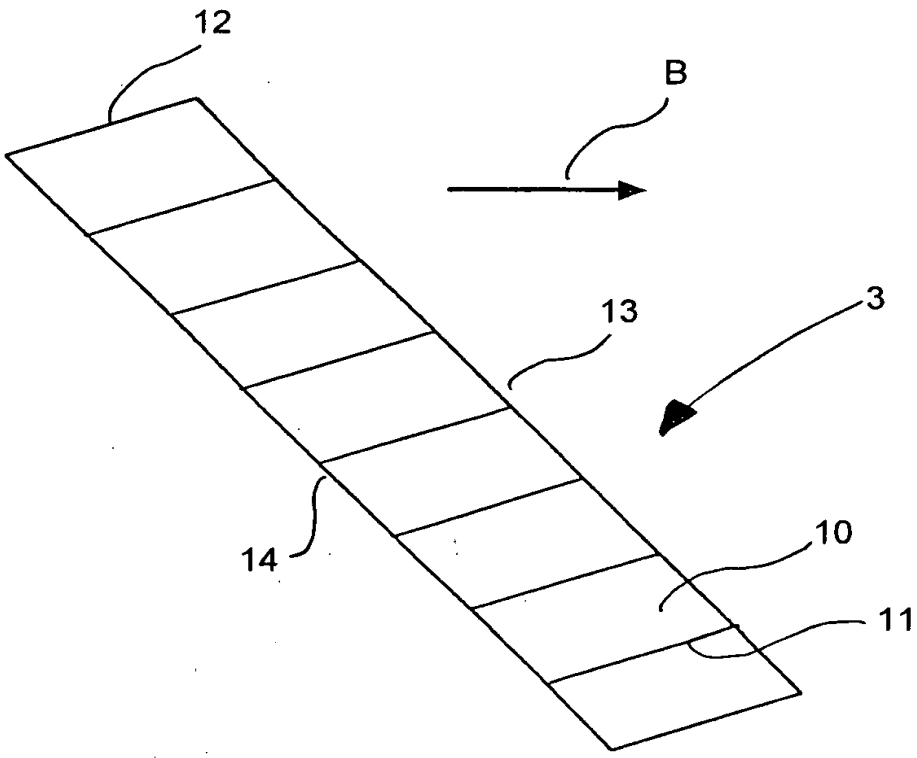


Fig. 5

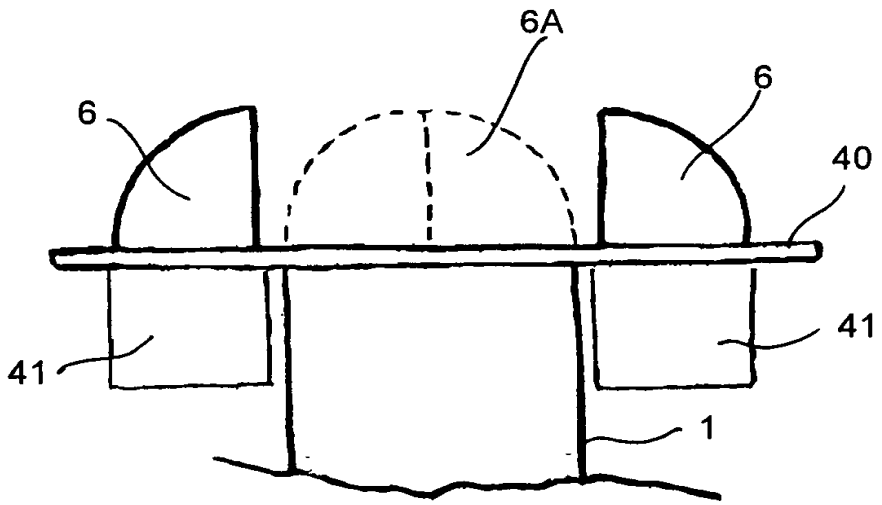


Fig. 6

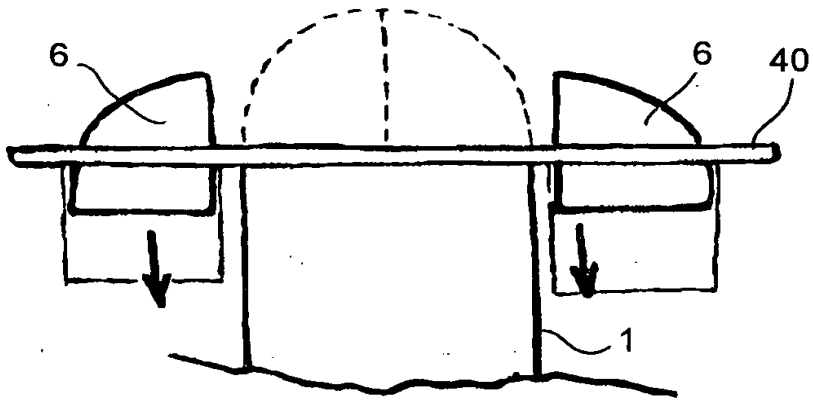


Fig. 7

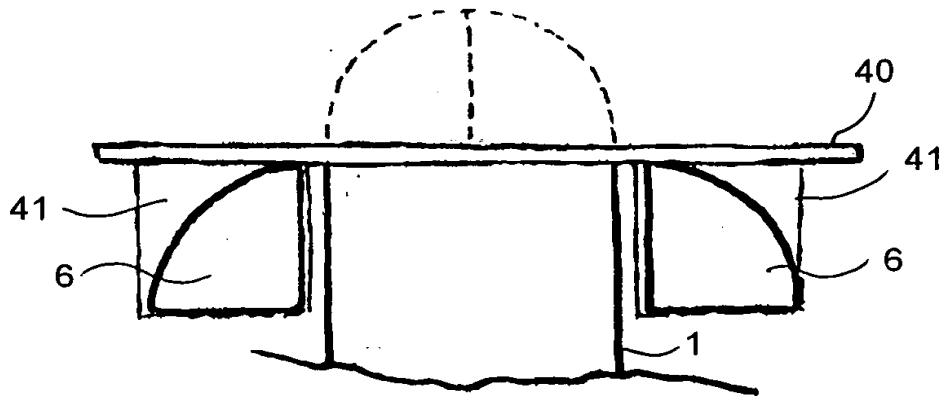


Fig. 8

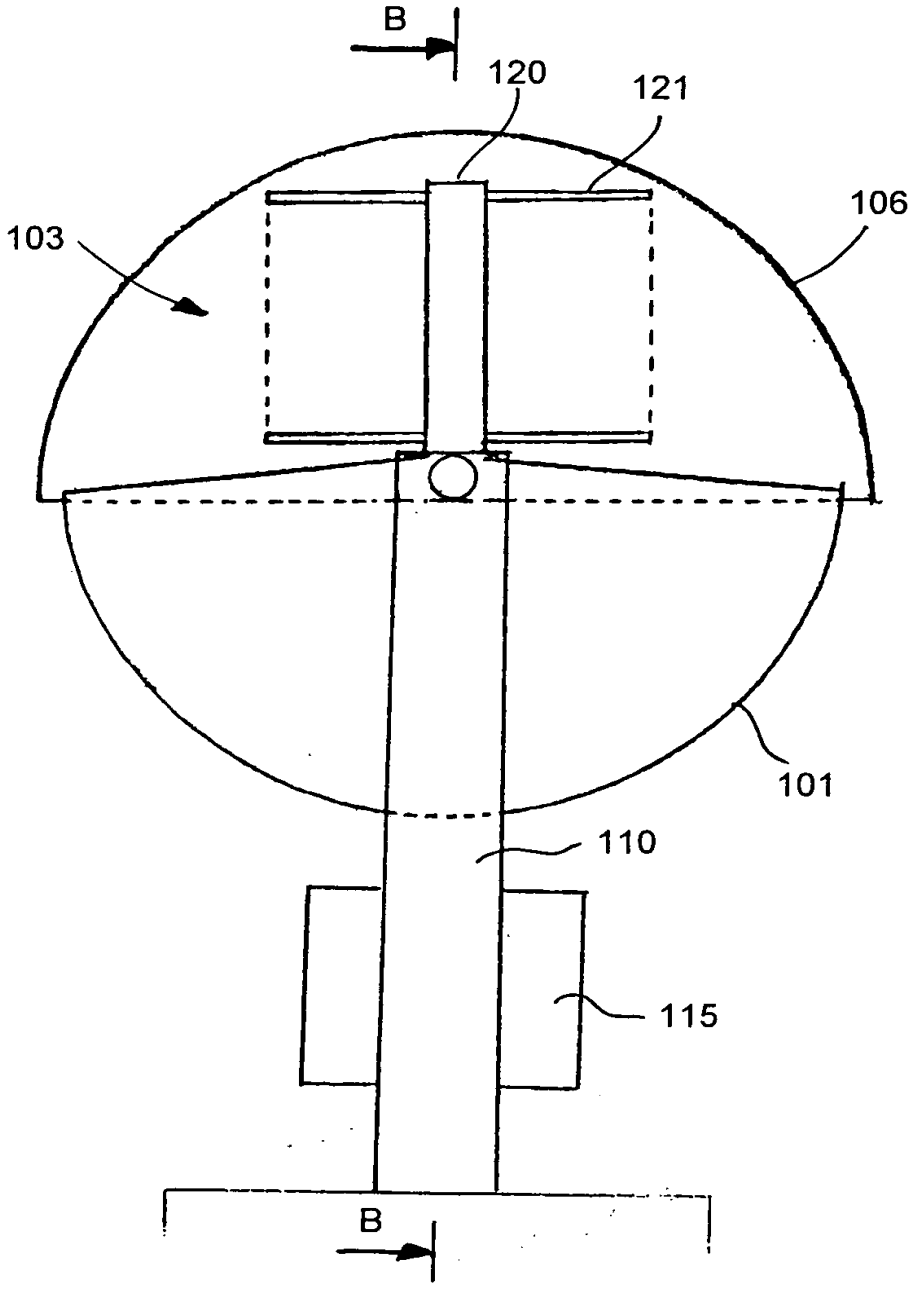


Fig. 9

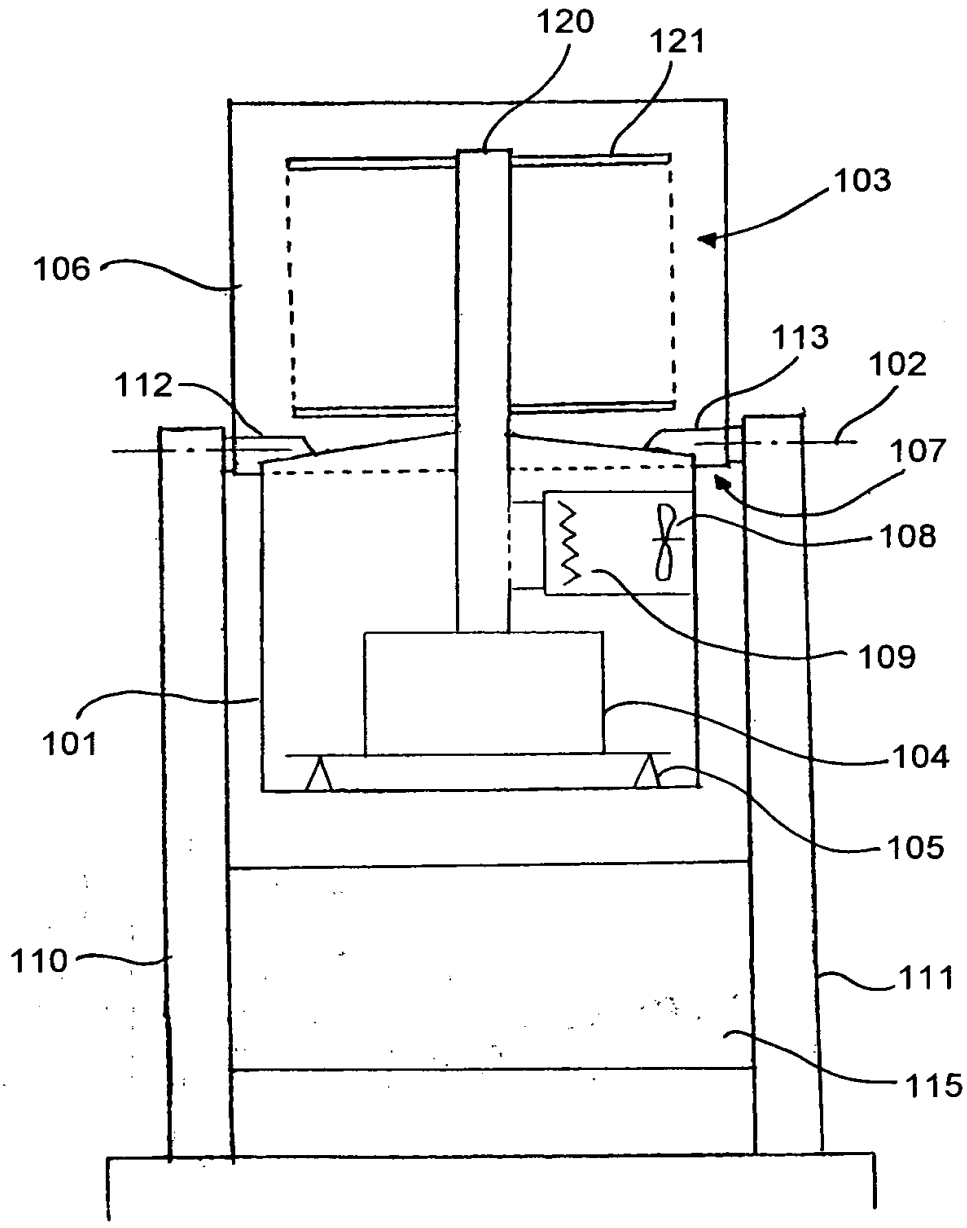


Fig. 10

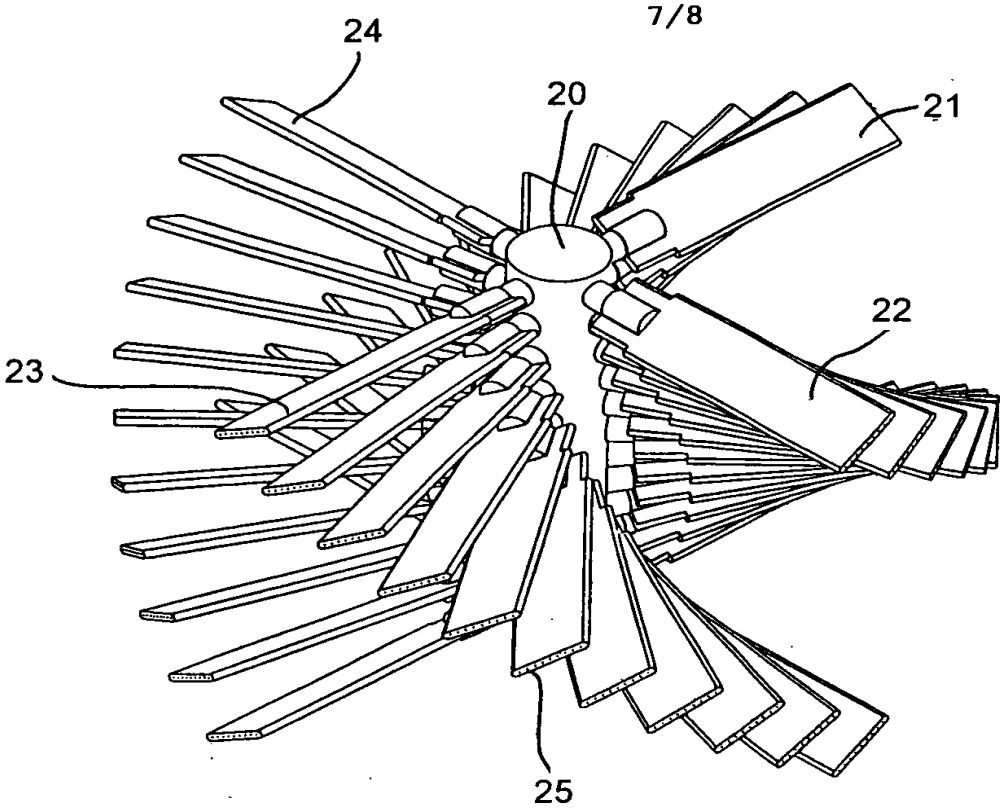


Fig. 11

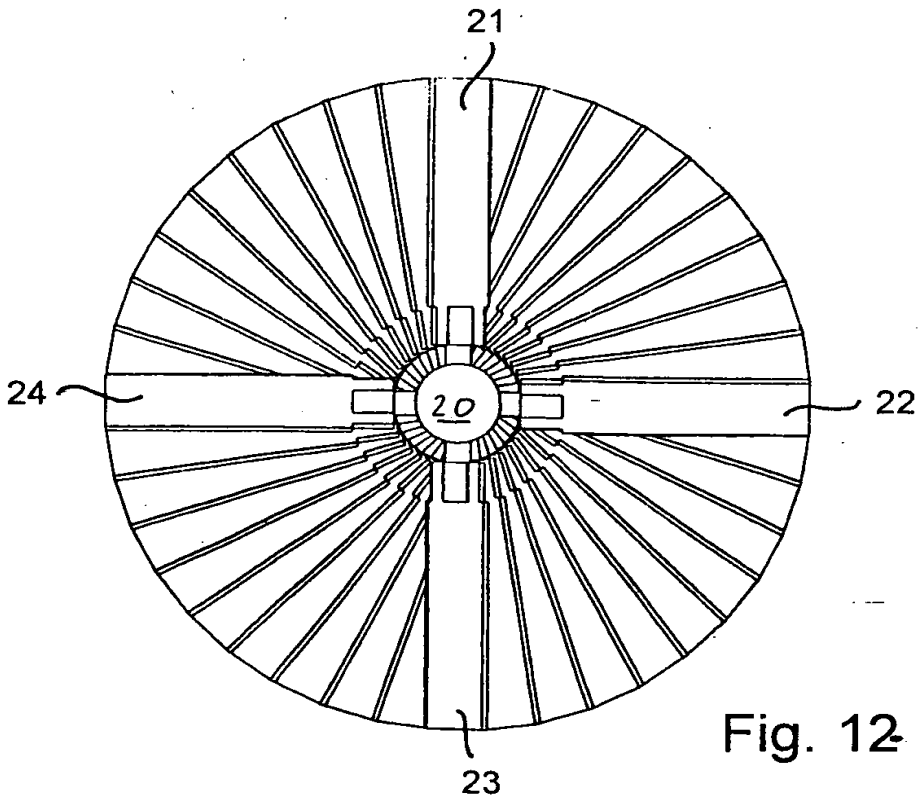


Fig. 12

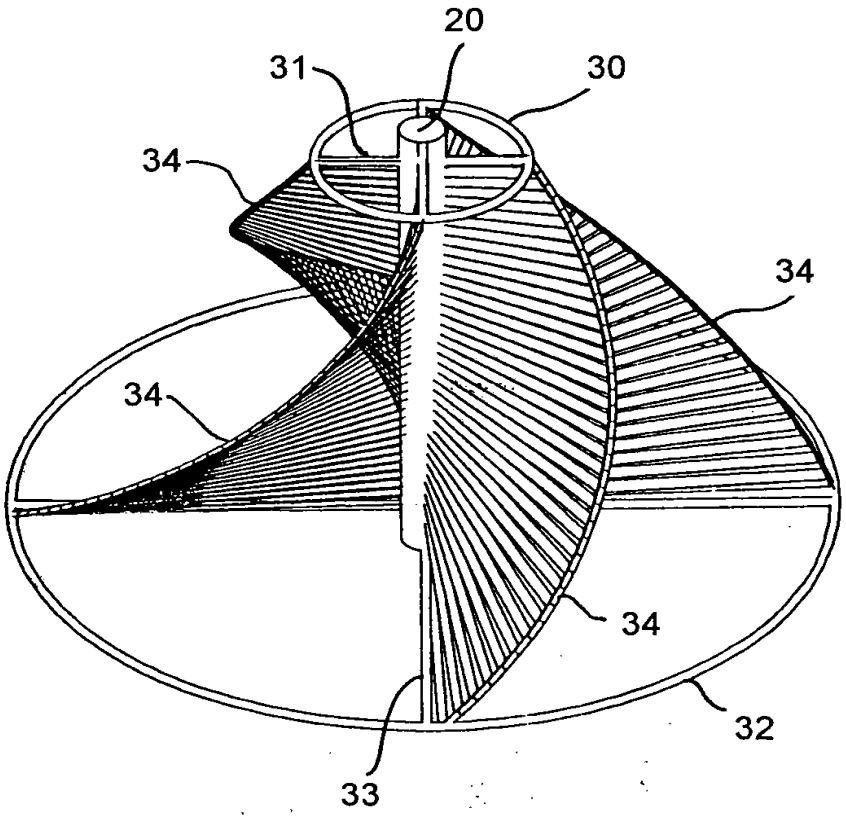


Fig. 13

Fremgangsmåde og apparat til måling af overisning

Den foreliggende opfindelse vedrører en fremgangsmåde og et apparat til lokal måling af en overisningsfaktor for atmosfærisk luft indeholdende underafkølet vand.

Sådanne målinger anvendes specielt men ikke udelukkende indenfor luftfart og søfart, hvor overisning kan udgøre en væsentlig sikkerhedsrisiko for havari.

Problemet opstår som følge af nedbør i form af regn og dis, som i underafkølet tilstand har en kendt tendens til at fryse sig fast til genstande såsom skrog og maskindele på såvel skibe som fly.

I praksis foretages der derfor under kritiske vejrforhold ofte manuelle observationer med henblik på at danne et indtryk af den øjeblikkelige overisningsfare, således at fly og skibe evt. kan varsles.

Et problem i denne sammenhæng er at denne manuelle observation baseres på et subjektivt skøn, og at der derved ikke opnås en standardiseret værdi for overisningsfaren. En varsling baseret på et sådant subjektivt skøn, vil således være behæftet med en del usikkerhed, og den der modtager varslingen, kan ikke umiddelbart danne sig et sikkert indtryk af overisningsfaren, ud over at forlede sig på den anbefaling som varslingen indebærer.

Fra US patent nr. 4 730 485, og fra NO fremlæggelsesskrift nr. 151 060, kendes der således apparater der er indrettet til at foretage en mere standardiseret måling af nedbørsmængden.

US patent nr. 4 730 485 angiver således en stationær måleindretning som er indrettet til at måle såvel vindhastighed som vindretning, men som også egner sig til måling af den aktuelle overisning.

NO fremlæggelse nr. 151 060 angiver et stationært vejeapparat til vejning af en nedbørsmængde i form af sne eller is, som lægger sig på en i hovedsagen horisontal vejeplade.

Et problem ved disse kendte indretninger er dog at overisning ofte kan forekomme i situationer hvor luften er relativt stillestående, og at den med disse indretninger målte overisningsfaktor i sådanne situationer er misvisende idet der kun afsættes lidt is på indretningerne.

Et yderligere problem ved den kendte indretning ifølge NO fremlæggelsesskrift nr. 151 060, er yderligere at anden nedbør end underafkølet vand, vil kunne lægge sig på vejepladen og derved giver et misvisende måleresultat i relation til overisningsfaktoren.

Formålet med den foreliggende opfindelse er derfor at angive en fremgangsmåde og et apparat, hvormed der under de fleste vejrforhold, og specielt også ved svage vinde eller stillestående luft, kan tilvejebringe et standardiseret måleresultat eller en standardiseret værdi for overisningsfaktoren.

Dette opnås ifølge den foreliggende opfindelse ved fremgangsmåden ifølge krav 1, eller ved brug af et apparat ifølge krav 7.

Fremgangsmåden ifølge den foreliggende opfindelse er således speciel ved at den omfatter følgende procestrin:

Tilvejebringelse af i det mindste et fladeelement som er udført i et materiale der egner sig for fastfrysning af is i atmosfærisk luft, hvilket element har et forudbestemt overfladeareal,

temperering af fladeelementet/fladeelementerne til en temperatur der i hovedsagen svarer til temperaturen for den atmosfæriske luft, hvor der derefter skabes relativ bevægelse med en forudbestemt hastighed mellem den atmosfæriske luft og fladeelementet/fladeelementerne, fortrinsvis ved at fladeelementet/fladeelementerne bevæges gennem den atmosfæriske luft, og i et forudbestemt tidsinterval, og hvor tykkelsen eller massen af den på fladeelementet/fladeelementerne fastfrosne is derefter måles ved hjælp af en dertil indrettet måler.

Herved kan der nemlig opnås på den ene side at anden nedbør end underafkølede regndråber eller dis, kun vanskeligt kan lægge sig på fladeelementerne og påvirke måleresultaterne uønsket, samt at der herved muliggøres at der kan foretages relativt nøjagtige målinger af overisningsfaktoren også i relativt stillestående luft.

I tilfælde af at det er islagstykkelsen, der måles, kan der for at opnå en repræsentativ værdi for denne med fordel måles på et antal steder, fortrinsvis på et eller flere steder på hvert fladeelement, hvorefter værdierne kan adderes til en enkelt værdi.

Den således målte værdi for islagstykkelse eller vægtforøgelse vil være en standardiseret faktor, der indikerer en relativ risiko for overisning af f.eks. fly eller skibe i området for målingen. Det er klart, at der kun kan være tale om en indikator for risikoen, da denne selvsagt vil variere mere eller mindre i forhold til det sted, hvor målingen er foretaget.

Fremgangsmåden kan fordelagtigt udøves ved brug af et apparat ifølge krav 7, hvilket apparat omfatter i det mindste et fladeelement som er udført i et materiale der egner sig for fastfrysning af is i atmosfærisk luft, og hvilket fladeelement har et forudbestemt overfladeareal, og hvor apparatet yderligere omfatter midler der er indrettet til at bevæge fladeelementet gennem den atmosfæriske luft med en forudbestemt hastighed og i et forudbestemt tidsinterval, og hvor der yderligere er midler der er indrettet til at måle tykkelsen eller massen af den på fladeelementet fastfrosne is efter det forudbestemte tidsinterval hvor fladeelementet bevæges gennem den atmosfæriske luft.

Ved en fortrukken udførelse for fremgangsmåden sikres det, at eventuel fastfrossen is fjernes før en første måling, ligesom den fastfrosne is fjernes fra det enkelte fladeelement efter målingen af dennes masse eller tykkelse, hvorefter der kan foretages en ny måleproces. Denne fjernelse af isen kan fordelagtigt udføres ved at opvarme de enkelte fladeelementer, enten udefra eller indefra.

Det er yderligere fordelagtigt af hensyn til at opnå ensartede måleresultater, såfremt der tilvejebringes en overdækning der strækker sig i det mindste hen over fladeelementet, og dækker og afskærmer fladeelementet, og hvilken overdækning fjernes fra fladeelementet i det mindste i det forudbestemte tidsinterval, hvor fladeelementet bevæges gennem den atmosfæriske luft med en forudbestemt hastighed.

Målenøjagtigheden kan yderligere øges såfremt fladeelementet bevæges gennem den atmosfæriske luft med en hastighed der sikrer at nedbør der ikke fryser fast til

fladeelementet i det væsentligste slynges af fladeelementet.

For at sikre, at den indvendige side af overdækningen er beskyttet mod at nedbør slår sig ned på denne, kan denne med fordel anbringes således i sin anden position, at dens inderside er beskyttet mod nedbør. Herved sikres det, at nedbør ikke vil kunne dryppe fra overdækningens inderside og ned på fladeelementerne, når overdækningen føres ind over disse.

For at sikre, at fladeelementerne i det væsentlige er fri for anden nedbør end is inden mængden heraf bestemmes, kan disse med fordel roteres i et forudbestemt tidsinterval efter at overdækningen er ført tilbage til dennes første position.

Ved en specielt simpel fremgangsmåde anvendes der i det mindste to fladeelementer der er roterbart placeret på en rotoraksel, således at bevægelsen af de to fladeelementer foregår ved en rotation af disse omkring rotorakselen.

Apparatet omfatter i en specielt simpel udførelsesform en vejeindretning som er indrettet til at veje og registrere i det mindste fladeelementets vægt før og efter at fladeelementet bevæges gennem den atmosfæriske luft.

Ved en specielt simpel udførelsesform omfatter apparatet en rotor med en rotoraksel, og i det mindste to fladeelementer der strækker sig fra rotorakselen og ud fra denne, og hvor der er indrettet midler til at rotere rotoren om sin akse. Herved opnås at de bevægemekanismer der tilvejebringer bevægelsen af fladeelementerne gennem luften, kan udføres meget simpelt og vedligeholdelsesfrit.

Apparatet kan dertil af hensyn til yderligere at opnå en øget målenøjagtighed omfatte en overdækning som er indrettet til at indtage en første position hvor den strækker sig hen over fladeelementet, og derved afdækker dette opadtil, samt en anden position hvor overdækningen er fjernet fra fladeelementet og ikke dækker dette, og denne overdækning er fortrinsvis indrettet således at den i sin første position danner et lukket rum omkring fladeelementet.

For at kunne foretage hurtige målinger efter hinanden, kan der hensigtsmæssigt være indrettet midler, der dels kan opvarme fladeelementerne for at smelte den afsatte is, dels nedkøle dem til tilnærmelsesvis omgivelsestemperatur. Dette kan realiseres ved at fladeelementerne er indrettet med kanaler, og at apparatet omfatter midler, således at luft kan ledes gennem kanalerne, som enten opvarmet luft eller luft med tilnærmelsesvis omgivelsestemperatur. Opvarmning og afkøling af fladeelementerne vil også kunne ske ved at det under overdækningen lukkede rum opvarmes og afkøles.

Det er ønskeligt at isdannelsen på fladeelementerne er så stor som mulig af hensyn til målenøjagtigheden og målehastigheden, og derfor udgøres fladeelementet i en første foretrukket udførelsesform af en plade med en forside og en i forhold hertil modsat orienteret bagside, og hvor pladen er indrettet på en sådan måde at pladens forside vender i den retning hvormed fladeelementet bevæges gennem den atmosfæriske luft, og hvor der gennem pladen strækker sig et flertal af kanaler fra pladens forside til pladens bagside, således at den atmosfæriske luft kan strømme gennem kanalerne fra pladens forside til pladens bagside.

I en anden foretrukket udførselsform omfatter apparatet et system af fladeelementer monteret på en roterbar akse, der er indrettet til at kunne anbringes i en i det væsentlige lodret position. De enkelte fladeelementer er udformet og anbragt således, at de enkelte fladeelementer svarende til deres projektionen på en flade vinkelret på den roterbare akse støder op til eller overlapper med andre fladeelementer, således at der ikke er mellemrum mellem de enkelte fladeelementer, når apparatet betragtes oppefra. Herved opnås, at al faldende nedbør indenfor apparatets udstrækning rammer fladeelementerne og derved har mulighed for at afsættes som is. Desto større overlappet er mellem de enkelte fladeelementer, under desto større afvigelse fra lodret faldende nedbør vil dette sikres.

Svarende til hvad der er anført ovenfor, kan fladeelementerne med fordel udformes og anbringes således, at de enkelte fladeelementer svarende til deres projektionen på en flade parallel med den roterbare akse støder op til eller overlapper med andre fladeelementer, således at der ikke er mellemrum mellem de enkelte fladeelementer, når apparatet betragtes fra siden. Herved opnås, at den atmosfæriske luft, der føres henover fladeelementerne ved den relative bevægelse mellem den atmosfæriske luft og fladeelementerne rammer et fladeelement og derved har mulighed for at afsætte det indeholdte vand som is.

Ved udførselsformer som ovenfor anført sikres det, at apparatet kan udformes med de mindst mulige fysiske dimensioner.

Apparatet ifølge den foreliggende opfindelse egner sig specielt til brug i lufthavne, hvor apparatet fortrinsvis kan være placeret på jordoverfladen ved en lufthavn, og hvorved apparatet omfatter midler til registrering af de

målte resultater af den på fladeelementerne afsatte is tykkelse eller masse, samt midler til visuelt eller auditivt at give signal til lufthavnens overvågningspersonel om måleresultatet.

Opfindelsen beskrives nærmere i det følgende under henvisning til tegningen, hvor:

Fig. 1 til 4 er principtegninger der ved hjælp af et skematisk repræsenteret apparat viser forskellige procestrin ifølge den foreliggende opfindelse,

fig. 5 er en snitskitse der viser et lodret snit gennem et fladeelement til brug i apparatet ifølge den foreliggende opfindelse,

fig. 6 til 8 viser en første fortrukken udførselsform for et apparat ifølge opfindelsen med afdækningen vist i forskellige positioner,

fig. 9 viser en anden fortrukken udførselsform for et apparat ifølge opfindelsen set fra siden,

fig. 10 viser et lodret snit gennem apparatet vist i figur 9 svarende til planet indikeret med B-B,

fig. 11 viser en fortrukken udførselsform for et rotorelement til brug i forbindelse med opfindelsen,

fig. 12 viser rotorelementet svarende til fig. 11 set oppefra, og

fig. 13 viser en yderligere fortrukken udførselsform for et rotorelement til brug i forbindelse med opfindelsen.

På fig. 1 ses således den principielle opbygning af et apparat ifølge opfindelsen, hvilket apparat omfatter et hus eller stel 1, hvori der er anbragt en aksel eller rotor 2, som bærer to diametralt placerede fladeelementer 3, og som drives rundt af en drivenhed 4 i pilens A retning. Rotoren med et eller flere fladeelementer anbragt benævnes også rotorelementet.

Svarende til den normale driftstilstand for apparatet er akselen eller rotoren indrettet til at kunne anbringes i en i det væsentlige lodret position. Når der i det følgende refereres til lodret og vandret er det med henvisning til apparatet anbragt i en sådan fortrukken position.

Apparatet omfatter endvidere en vejeindretning 5, som er indrettet til at veje fladeelementerne 3, rotoren 2 og drivenheden 4, hvorved en vægtforøgelse kan bestemmes.

Apparatet omfatter endvidere en bevægelig overdækning, i fig. 1 til 4 vist som en kuppelformet afskærmning bestående af to kvarte kugleskaller 6, som i fig. 1 vises i en første position hvor de afskærmer fladeelementerne 3 og rotoren 2, og danner et i hovedsagen lukket rum 7 omkring fladeelementerne og rotoren.

Apparatet omfatter endvidere en blæser 8 indrettet til at lede atmosfærisk luft mod fladeelementerne 3.

I det på fig. 1 viste procestrin roteres rotoren således rundt i det lukkede rum 7, og som følge af at blæseren 8 danner luftcirkulation i rummet, bringes fladeelementerne 3 til at indtage en temperatur der i hovedsagen svarer til omgivelsernes temperatur.

Herefter ses der på fig. 2 et efterfølgende procestrin, hvor de to kvarte kugleskaller 6 er trukket tilbage i en anden position hvor fladeelementerne 3 på rotoren 2 roteres i den fri luft, og hvor der, såfremt der forefindes underafkølet vand i luften, vil afsætte sig isdannelser på fladeelementerne 3. Af figuren fremgår det, at overdækningen i dennes anden position befinder sig i huset, der med fordel kan udformes således, at den indvendige side af overdækningen er beskyttet mod at nedbør slår sig ned på denne. Dette kunne i den viste fremstilling realiseres ved at overdæknings kugleskaller føres ned i huset gennem en smal åbning mellem husets overside og sidevægge. Ved en sådan udformning sikres det, at nedbør ikke vil kunne dryppe fra overdækningens inderside og ned på fladeelementerne, når overdækningen føres ind over disse.

Det på fig. 2 viste procestrin foretages ifølge opfindelsen i et foruddefineret tidsinterval, således at der vil kunne afsætte sig en passende mængde is på fladeelementerne, og rotoren roteres med en hastighed der på den ene side tager højde for at isen ikke slynges af rotoren, men hvor evt. anden nedbør i form af regn og sne slynges af i et passende omfang. Som vist i figuren skal det selvfølgelig sikres, at overdækningen kan føres forbi husets forskellige strukturer.

Vejeindretningen kan med fordel udformes med tre vejeceller anbragt i trekant mellem drivenheden 4 og husets nedre del. Herved sikres en stabil vægtbestemmelse af drivenheden, rotoren, fladeelementerne og den sig derpå befindende fastfrosne is.

Efter det på fig. 2 viste procestrin vises der et efterfølgende trin på fig. 3, hvor overdækningen er ført tilbage til dens første position. For at sikre, at fladeelementerne i det væsentlige er fri for anden nedbør end is

inden mængden heraf bestemmes, kan disse med fordel roteres i et forudbestemt tidsinterval efter at overdækningen er ført tilbage til dennes første position.

Herefter bringes fladeelementerne til standsning, og vægtforøgelsen af fladeelementerne som følge af den på disses overflader afsatte is, registreres ved hjælp af vejeindretningen 5, og der kan udfra den målte værdi generes et signal til visning af en overisningsfaktor, idet der dog ikke på tegningen vises udstyr hertil fordi et sådant udstyr vil være nærliggende for en fagmand at udforme på baggrund af den foreliggende beskrivelse.

Herefter vises der et følgende procestrin i fig. 4, hvor de to kvarte kugleskaller 6 er bevæget hen over fladeelementerne 3 og afskærmer disse, således at der igen dannes det førnævnte lukkede rum 7. I dette procestrin bringes rotoren til at rotere, og der foretages en hurtig opvarmning af det lukkede rum 7 ved hjælp af blæseren 8 og et varmeelement 9, således at den på fladeelementerne afsatte is smeltes og slynges af ved rotorens rotation, hvorved rotorens 2 og fladeelementernes 3 samlede vægt bringes tilbage til udgangsvægten.

Herefter kan der fortsættes med det i fig. 1 viste procestrin, og apparatet ifølge opfindelsen er således velegnet til at foretage gentagne målinger med meget stor nøjagtighed under standardiserede betingelser.

Af hensyn til at opnå en så stor målenøjagtighed som muligt bør fladeelementerne 3 udføres med en så stor overflade for vedhæftning af is som muligt. I fig. 5 er vist en udførselsform, hvor et fladeelement er opbygget som en rist, hvor der ses et lodret snit gennem denne, og hvor det ses at fladeelementet, som bevæges i pilens B retning, har en forside 13 og en bagside 14, og hvor der ved

hjælp af vægge 11, 12 dannes kanaler 10, som strækker sig fra forsiden 13 til bagsiden 14.

Derved danner fladeelementet en, i forhold til fladeelementets egenvægt, relativt stor overflade for vedhæftning, således at der kan opnås relativt hurtig dannelse af en passende og målbar mængde is på fladeelementets 3 overflader, og således at fladeelementet hurtigt kan bringes til at indtage ønskede temperaturer ved opvarmningen som vist på fig. 4 og nedkølingen som vist på fig. 1.

Idet de ovennævnte vægge 11, 12 er skråt nedadtil forløbende opnås der på den ene side at anden nedbør end underafkølet vand eller dis, med stor sandsynlighed vil glide eller flyde af fladeelementet 3, men derudover at underafkølede vanddråber eller dis, med stor sandsynlighed vil afsættes på fladeelementets overflader uden at passere hele vejen gennem fladeelementet.

De i fig. 1 til 4 viste fladeelementer er for overskuelighedens skyld vist meget små, men i en fortrukken udførselsform er de dimensioneret til i det væsentlige at udfylde rummet 7, hvad der vil betyde, at fladeelementerne som vist i fig. 1 til 4 tilsammen skulle udgøre tilnærmelsesvis en halvcirkel. Dette sikrer, at apparatet kan udformes med de mindst mulige ydre mål.

Som ovenfor beskrevet bør det sikres, at overdækningens inderside er beskyttes mod nedbør under alle procestrin, dette for at sikre en præcis bestemmelse af mængden af fastfrossen is.

Fig. 6 til 8 viser en udførselsform, hvor et apparatet omfatter et hus 1, en overdækning i form a to kvarte kugleskaller 6, to opbevaringsenheder 41 for de to kvarte

kugleskaller og en platform 40 hvorpå opbevaringsenhederne er anbragt. Apparatet omfatter endvidere et rotorelement, en drivenhed og en vejeindretning (ikke vist) som beskrevet ovenfor.

I en første position dækker overdækningen 6A rotorelementet, og danner et i hovedsagen lukket rum; dette er antydet i fig. 6 med stiplede linier. Når en måling ønskes gennemført bevæges overdækningens elementer, som vist i fig. 6, 7 og 8, til deres anden position, hvor de opbevares beskyttet i opbevaringsenhederne 41. Da det i det væsentlige er overdækningens inderside, der skal beskyttes mod nedbør, kan det vælges, at lade opbevaringsenhederne være åbne opadtil, hvad der vil simplificere konstruktion. Når første del af målingen er gennemført, føres overdækningen tilbage til sin første position.

Ovenfor er skematisk antydet, hvordan en beskyttelse af overdækningens inderside mod vejrliget kan udføres, men det vil selvsagt være muligt at vælge overdækningens og opbevaringsenhedernes udformning, form og deres indbyrdes relation på mange forskellige måder.

Fig. 9 viser en yderligere udførselsform, hvor et apparatet omfatter et hus 101 med en drivenhed, et stel 110, en styreenhed 115, en overdækning 106 og et rotorelement 103. Huset 101 er udformet som en lukket i det væsentlige halv cylinder afskåret svarende til cylinderaksen; huset er monteret i et stel 110 således at cylinderaksen i det væsentlige er lejret vandret horisontalt. Overdækningen 106 er ligeledes udformet som en i det væsentlige halv cylinder afskåret svarende til dennes cylinderakse og åben svarende til snitfladen. Overdækningen er monteret på stellet 110 således at overdækningens cylinderakse i det væsentlige er sammenfaldende med husets cylinderakse. Overdækningen er udført med en større bredde (svarende

til længden på cylinderaksen) og en større cylinderradius end huset og drejeligt monteret på stellet således at overdækningens cylinderakse også udgør dennes omdrejningsakse. Denne anordning af overdækning og hus gør det muligt, at overdækningen ved en 180 graders rotation om sin omdrejningsakse kan føres fra sin første position som vist i fig. 9 og til en anden position under huset og således at huset i det væsentlige omsluttes af overdækningen. I fig. 9 er overdækningens endeflade mod betragteren fjernet, således at rotorelementet 103 anbragt ovenpå huset kan ses. Når overdækningen drejes bort som ovenfor beskrevet, vil rotorelementet være afdækket og en måling kan påbegyndes. Som også ovenfor beskrevet vil denne anordning sikre, at overdækningens inderside beskyttes mod nedbør mens denne er anbragt i sin anden position.

Med henvisning til fig. 10 ses et snit gennem apparatet vist i fig. 9 svarende til planet indikeret med B-B. Som det fremgår er huset 101 ved hjælp af to beslag 112, 113 monteret i et stel bestående at to standere 110, 111. Som ovenfor beskrevet er såvel huset som overdækningen monteret med deres respektive cylinderakse omkring en fælles akse 102. Rotorelementet 103 omfatter en rotoraksel 120 og et system af fladeelementer, hvoraf kun de øverste 121 og nederste er vist. Rotorelementets generelle cylinderform er antydet med stiplede linier. I mellemrummet 107 mellem overdækningen og huset kan med fordel anbringes en tætning, hvad der både forhindre at nedbør trænger ned i mellemrummet mellem overdækningen og huset og at den nedbør der eventuelt har fundet vej til mellemrummet vil blive fjernet fra overdækningens inderside, når denne føres fra sin anden til sin første position. Som vist i fig. 9 og 10 er husets overside udformet som en opad konisk flade, hvad der sikrer, at for eksempel smeltevand ved opvarmning af fladeelementerne ledes bort fra huset og specielt bort fra rotorakselens gennemføring.

Mellem standerne er anbragt en kontrolenhed 115 til styring af drivenhed 104, vejeindretning 105, blæser 108 og varmeelement 109, samt til opsamling, lagring og eventuel videresendelse af måledata. Disse enheder er indrettet til at fungere på tilsvarende måde som anført ovenfor med henvisning til fig. 1 til 4. I fig. 10 er indikeret, at luft ved hjælp af blæseren 8 indblæses i rotorakselen og derfra ledes ud gennem fladeelementerne som også beskrevet ovenfor. Mellem husets overdel og rotorakselen kan med fordel anbringes en lejeanordning (ikke vist) til støtte og føring af akselen. I en fortrukken udførselsform omfatter apparatet endvidere midler (ikke vist) til automatisk at bevæge overdækningen mellem dennes første og anden position. Det er indlysende, at apparatet omfatter en indretning til sikring af overdækningen i dennes første position, fortrinsvis også i dennes anden position.

En fortrukken udførselsform for et rotorelement til brug for et apparat ifølge opfindelsen vil nu blive beskrevet med henvisning til fig. 11, 12 og 13.

I fig. 11 omfatter rotorelementet en aksel 20 hvorpå er anbragt fire stakke, hver bestående af et antal fladeelementer anbragt med indbyrdes afstand over hinanden med de respektive øverste fladeelementer 21, 22, 23, 24 anbragt i et øverste plan. Hvert fladeelement har en fri ydre ende og en indre ende fastgjort til aksen. De øverste fladeelementer er anbragt med en konstant indbyrdes vinkelafstand, som for fire øverste fladeelementer svarer til en vinkel på 90 grader.

Som det fremgår af figuren er fladeelementerne i den enkelte stak forskudt i forhold til hinanden, med de ydre frie ender anbragt svarende til at de overordnet danner

en helix. For hver stak strækker denne helix sig mindst over en vinkel svarende til vinklen mellem to efter hinanden anbragte stakke. For en udførselsform med fire stakke strækker en helix sig således over mindst 90 grader. I det specielle tilfælde, hvor der kun anvendes en enkelt stak vil denne strække sig en fuld omdrejning omkring akselen, dvs. 360 grader.

De enkelte fladeelementer er udformet og anbragt således at de, svarende til deres projektionen på en vandret flade, overlapper med det eller de fladeelementer som det enkelte fladeelement er anbragt ved siden af respektive imellem, således at der ikke er mellemrum mellem de enkelte fladeelementer, når apparatet betragtes oppefra. Dette er illustreret i fig. 12, der viser apparatet svarende til fig. 11 set oppefra. Herved opnås, at al faldende nedbør indenfor apparatets udstrækning rammer fladeelementerne og derved har mulighed for at afsættes som is. Desto større overlappet er mellem de enkelte fladeelementer, under desto større afvigelse fra lodret faldende nedbør vil dette sikres.

Svarende til hvad der er anført ovenfor, er fladeelementerne i den viste udførselsform udformet og anbragt således, at de enkelte fladeelementer svarende til deres projektionen på en lodret flade støder op til eller overlapper med det eller de fladeelementer som det enkelte fladeelement er anbragt ved siden af respektive imellem, således at der ikke er mellemrum mellem de enkelte fladeelementer, når apparatet betragtes fra siden. Herved opnås, at den atmosfæriske luft, der føres henover fladeelementerne ved den relative bevægelse mellem den atmosfæriske luft og fladeelementerne rammer et fladeelement og derved har mulighed for at afsætte det indeholdte vand som is. Dette som beskrevet ovenfor med henvisning til figur 5.

Ved en udførselsform som vist i figur 11 og 12 sikres det, at apparatet kan udformes med de mindst mulige ydre dimensioner. For eksempel har en udførselsform med fire stakke af hver 11 fladeelementer og med en diameter på 70 cm vist sig hensigtsmæssig.

Som det også fremgår af figur 11 er de enkelte fladeelementer forsynet med at antal kanaler 25 igennem hvilke, der kan blæses luft, henholdsvis opvarmet luft for at afise fladeelementerne og luft med omgivelsestemperatur for at temperere fladeelementerne før næste måling. I en hensigtsmæssig udførselsform ledes luften fra apparatets basis til fladelementerne gennem akselen 20.

Svarende til udførselsformen vist i figur 11 er fladeelementerne kun fastgjort til akselen 20 svarende til deres ene ende, hvorfor det enkelte fladeelement er dimensioneret til at kunne bære sig selv og modstå de kræfter, der vil opstå ved den tilsigtede brug af apparatet. I en anden udførselsform vist i figur 13 er der anvendt et større antal mere spinkle fladeelementer, der dels er fastgjort svarende til deres indre ende til akselen, dels er fastgjort svarende til deres ydre ende til en støttestruktur. Denne støttestruktur omfatter et øvre støtteelement 30 fastgjort til akselen ved hjælp af øvre forbindelseselementer 31 og et nedre støtteelement 32 fastgjort til akselen ved hjælp af nedre forbindelseselementer 33. Mellem det øvre og nedre støtteelement er anbragt et antal ydre støtteelementer 34 til hvilke den ydre ende af fladeelementerne er fastgjort. Svarende til den ovenfor beskrevne udførselsformen er der også her anvendt fire stakke af fladelementer der tilsvarende støttes af fire ydre støttelementer 34.

Svarende til udførselsformen vist i figur 11 er fladeelementerne lige lange, således at hver helix forløber svarende til overfladen på en cylinder, ligesom den overordnede form af rotorelementet vil være en cylinder. I den anden udførselsform vist i figur 13 er der for hver stak anvendt fladeelementer med aftagende længde mod apparatets top; hvis længden aftager lineært vil det enkelte ydre støtteelement 34 forløbe svarende til en helix på overfladen af en konus, ligesom den overordnede form af rotorelementet her vil være en konus. Som ovenfor anført er det hensigtsmæssigt, at rotorelementets og overdækningens overordnede form og dimensioner svarer til hinanden. For en udførselsform for apparatet som vist i fig. 6 til 8 bør rotorelementet således have form som en halvkugle.

Det er selvfølgelig for begge de ovenfor beskrevne udførselsformer muligt at anbringe fladeelementer således, at de den beskrevne helix-form ikke vil være en "perfekt" geometrisk helix, men blot hvad fagmanden vil opfatte som "spiralformet".

Det er klart at fagmanden på basis af den ovennævnte forklaring af opfindelsens princip, let vil kunne angive forskellige udførelsesformer for såvel opbygning af et apparat, der kan gennemføre de nævnte procestrin, men også at kunne angive procesparametre som egner sig hertil under hensyntagen til apparatets udformning, såsom tidsintervallet hvormed fladeelementerne skal bevæges gennem den fri luft som vist på fig. 2, og hvilken hastighed som fladeelementerne 3 skal bevæges med gennem luften for opnåelse af passende måleresultater som ikke påvirkes væsentligt af, at der evt. afsættes anden nedbør på fladeelementerne 3 end underafkølet vand og dis. Det er indlysende, at der er en sammenhæng mellem udformningen af selve apparatet, og de driftsparametre, der sikrer at de ønskede måleresultater opnås.

P a t e n t k r a v :

1. Fremgangsmåde til lokal måling af en overisningsfaktor for atmosfærisk luft indeholdende underafkølet vand, k e n d e t e g n e t ved, at fremgangsmåden omfatter følgende procestrin:

tilvejebringelse af i det mindste et fladeelement (3) som er udført i et materiale der egner sig for fastfrysning af is i atmosfærisk luft, hvilket element har et forudbestemt overfladeareal,

hvor fladeelementet/fladeelementerne bringes til en temperatur der i hovedsagen svarer til temperaturen for den atmosfæriske luft,

hvor der derefter skabes relativ bevægelse med en forudbestemt hastighed mellem den atmosfæriske luft og fladeelementet/fladeelementerne, fortrinsvis ved at fladeelementet/fladeelementerne bevæges gennem den atmosfæriske luft, og i et forudbestemt tidsinterval,

og hvor tykkelsen eller massen af den på fladeelementet/fladeelementerne fastfrosne is derefter måles ved hjælp af en dertil indrettet måleindretning.

2. Fremgangsmåde ifølge krav 1, k e n d e t e g n e t ved, at den fastfrosne is efter målingen af dennes masse eller tykkelse, fjernes fra fladeelementet/fladeelementerne, hvorefter der kan foretages en ny måleproces.

3. Fremgangsmåde ifølge krav 2, k e n d e t e g n e t ved, at den fastfrosne is fjernes ved opvarmning af fladeelementet/fladeelementerne.

4. Fremgangsmåde ifølge et af foregående krav, k e n d e t e g n e t ved, at der tilvejebringes en overdækning der strækker sig i det mindste hen over fladeelementet/fladeelementerne, og dækker og afskærmer fladeelementet/fladeelementerne, og hvilken overdækning fjernes fra fladeelementet/fladeelementerne i det mindste i det forudbestemte tidsinterval, hvor fladeelementet/fladeelementerne bevæges gennem den atmosfæriske luft med en forudbestemt hastighed.

5. Fremgangsmåde ifølge krav 4, k e n d e t e g n e t ved, at fladeelementet/fladeelementerne bevæges i et forudbestemt tidsinterval efter at overdækningen efter en måling er bragt tilbage til sin første position, hvorefter tykkelsen eller massen af den på fladeelementet/fladeelementerne fastfrosne is måles.

6. Fremgangsmåde ifølge et hvert af ovenstående krav, k e n d e t e g n e t ved, at fladeelementet/fladeelementerne bevæges gennem den atmosfæriske luft med en hastighed der sikrer at nedbør der ikke fryser fast til fladeelementet/fladeelementerne i det væsentligste slynges af fladeelementet/fladeelementerne.

7. Fremgangsmåde ifølge et af ovenstående krav, k e n d e t e g n e t ved, at der anvendes i det mindste to fladeelementer som er roterbart placeret på en rotorakse1, og ved at bevægelsen af de to fladeelementer foregår ved en rotation af rotorakselen.

8. Apparat til lokal måling af en overisningsfaktor for atmosfærisk luft indeholdende underafkølet vand,

k e n d e t e g n e t ved, at apparatet omfatter i det mindste et fladeelement (3) som er udført i et materiale der egner sig for fastfrysning af is i atmosfærisk luft, hvor fladeelementet/fladeelementerne har et forudbestemt overfladeareal, og hvor apparatet yderligere omfatter midler (4) der er indrettet til at bevæge fladeelementet/fladeelementerne gennem den atmosfæriske luft med en forudbestemt hastighed og i et forudbestemt tidsinterval, og hvor der yderligere er midler (5) der er indrettet til at måle tykkelsen eller massen af den på fladeelementet/fladeelementerne fastfrosne is efter det forudbestemte tidsinterval hvor fladeelementet/fladeelementerne er blevet bevæget gennem den atmosfæriske luft.

9. Apparat ifølge krav 8, k e n d e t e g n e t ved, at det omfatter en vejeindretning (5) som er indrettet til at veje og registrere i det mindste fladeelementets/fladeelementernes vægt før og efter at fladeelementet/fladeelementerne bevæges gennem den atmosfæriske luft, samt at apparatet fortrinsvis omfatter midler til opvarmning af fladeelementet/fladeelementerne.

10. Apparat ifølge krav 8 eller 9, k e n d e t e g n e t ved, at apparatet omfatter et rotorelement med en rotoraksel (2), og i det mindste to fladeelementer (3) der strækker sig fra rotorakselen og ud fra denne, og hvor der er indrettet midler (4) til at rotere rotoren om sin akse.

11. Apparat ifølge ethvert af kravene 8 til 10, k e n d e t e g n e t ved, at apparatet omfatter en overdækning (6) med en mod fladeelementerne vendende inderside, og som er indrettet til at indtage en første position hvor den strækker sig hen over fladeelementet/fladeelementerne, der derved afdækkes opadtil, samt en anden

position hvor overdækningen er fjernet og ikke dækker fladeelementet/fladeelementerne.

12. Apparat ifølge krav 11, k e n d e t e g n e t ved, at overdækningen er indrettet således at den i sin første position danner et lukket rum (7) omkring fladeelementet/fladeelementerne.

13. Apparat ifølge krav 12, k e n d e t e g n e t ved, at der er indrettet midler (8, 9) til opvarmning af det under overdækningen lukkede rum.

14. Apparat ifølge ethvert af kravene 11 til 13 k e n d e t e g n e t ved, at apparatet er indrettet til at bevæge fladeelementet/fladeelementerne i et forudbestemt tidsinterval efter at overdækningen (6) efter en måling er bragt tilbage til dennes første position, hvorefter tykkelsen eller massen af fastfrossen is kan bestemmes.

15. Apparat ifølge ethvert af kravene 11 til 14 k e n d e t e g n e t ved, at overdækningen i sin anden position er anbragt således, at dens inderside i det væsentlige er beskyttet mod nedbør og således holdes tør.

16. Apparat ifølge ethvert af kravene 8 til 15, k e n d e t e g n e t ved, at fladeelementet/fladeelementerne hver især udgøres af en plade med en forside (13) og en i forhold hertil modsat orienteret bagside (14), og hvor pladen er indrettet på en sådan måde at pladens forside vender i den retning hvormed det respektive fladeelement bevæges gennem den atmosfæriske luft, og hvor der gennem pladen strækker sig et flertal af kanaler (10) fra pladens forside til pladens bagside, således at den atmosfæriske luft kan strømme gennem kanalerne fra pladens forside til pladens bagside.

17. Apparat ifølge et hvert af kravene 8 til 16, k e n d e t e g n e t ved, at apparatet omfatter et system af fladeelementer (21, 22, 23, 24) monteret på en roterbar aksel (20), der er indrettet til at kunne anbringes i en i det væsentlige lodret position, og hvor de enkelte fladeelementer er udformet og anbragt således, at de enkelte fladeelementer svarende til deres projektionen på en flade vinkelret på den roterbare akse støder op til eller overlapper med andre fladeelementer, således at der ikke er mellemrum mellem de enkelte fladeelementer, når apparatet betragtes oppefra, og således at al faldende nedbør indenfor apparatets udstrækning, når den roterbare akse er anbragt lodret, i det væsentlige rammer fladeelementerne og derved har mulighed for at afsættes som is.

18. Apparat ifølge krav 17, k e n d e t e g n e t ved, at fladeelementerne er udformet og anbragt således, at de enkelte fladeelementer svarende til deres projektionen på en flade parallel med den roterbare aksel (20) støder op til eller overlapper med andre fladeelementer, således at der ikke er mellemrum mellem de enkelte fladeelementer, når apparatet betragtes fra siden, og således at den atmosfæriske luft, der føres henover fladeelementerne i en retning i det væsentlige vinkelret på akslen ved en relativ bevægelse mellem den atmosfæriske luft og fladeelementerne i det væsentlige rammer et fladeelement og derved har mulighed for at afsætte det indeholdte vand som is.

19. Apparat ifølge et hvert af kravene 8 til 18, k e n d e t e g n e t ved, at fladeelementerne er indrettet med kanaler, og at apparatet omfatter midler, således at luft kan ledes gennem kanalerne, fortrinsvis som enten opvarmet luft eller luft med tilnærmelsesvis omgivelsestemperatur.

20. Apparat ifølge et af kravene 8 til 19, k e n d e - t e g n e t ved, at apparatet er placeret på jordoverfladen ved en lufthavn, og ved at apparatet omfatter midler til registrering af de målte resultater af den på fladeelementet/fladeelementerne afsatte is' tykkelse eller masse, samt midler til visuelt eller auditivt at give signal til overvågningspersonel om måleresultatet, fortrinsvis ved at apparatet omfatter midler, der kan omsætte den målte tykkelse eller masse til en værdi, der indikerer en risiko for overisning.

Sammendrag:

Apparat og fremgangsmåde til lokal måling af en overisningsfaktor for atmosfærisk luft indeholdende underafkølet vand, og hvor apparatet omfatter i det mindste et fladeelement som er udført i et materiale der egner sig for fastfrysning af is i atmosfærisk luft, og hvilket fladeelement har et forudbestemt overfladeareal, og hvor apparatet yderligere omfatter midler der er indrettet til at bevæge fladeelementet gennem den atmosfæriske luft med en forudbestemt hastighed og i et forudbestemt tidsinterval, og hvor der yderligere er midler der er indrettet til at måle tykkelsen eller massen af den på fladeelementet fastfrosne is efter det forudbestemte tidsinterval hvor fladeelementet bevæges gennem den atmosfæriske luft.

Fig. 9

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G01W 1/00, 1/14 — A1

(11) International Publication Number: **WO 00/54078**

(43) International Publication Date: 14 September 2000 (14.09.00)

(21) International Application Number: PCT/DK00/00094

(22) International Filing Date: 7 March 2000 (07.03.00)

(30) Priority Data:
PA 1999 00323 8 March 1999 (08.03.99) DK

(71)(72) Applicant and Inventor: NIELSEN, Evan [DK/DK]; Holmevej 35, DK–9640 Farsø (DK).

(74) Agent: HOFMAN–BANG A/S; Hans Bekkevolds Allé 7, DK–2900 Hellerup (DK).

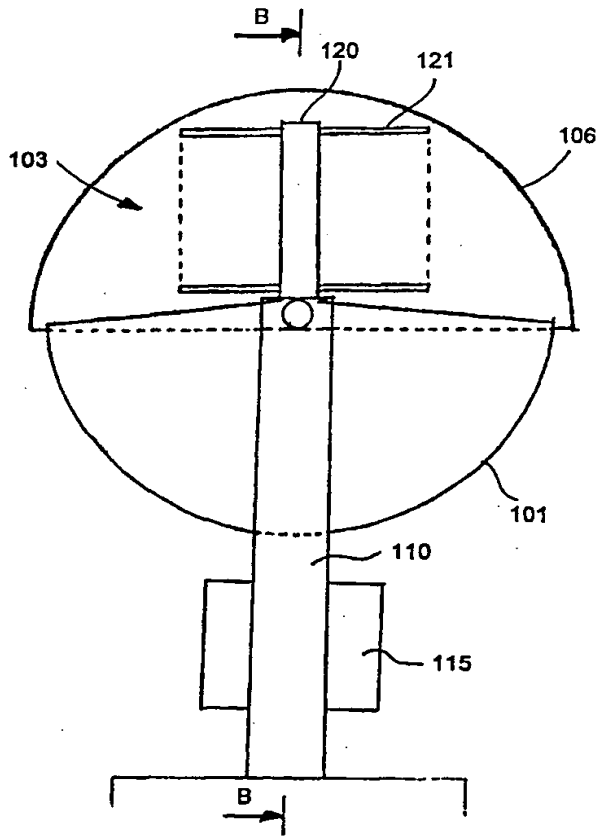
(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Danish).

(54) Title: A METHOD AND AN APPARATUS FOR MEASURING ICING

(57) Abstract

An apparatus and a method for local measurement of an icing factor for atmospheric air containing supercooled water, and wherein the apparatus comprises at least one surface element made of a material suitable for ice in atmospheric air to freeze on, and said surface element having a predetermined surface area, and wherein the apparatus further comprises means that are configured for moving the surface element through the atmospheric air at a predetermined rate and for a predetermined period of time, and wherein means are also provided that are configured for measuring the thickness or mass of the ice frozen fast onto the surface element after the predetermined time interval during which the surface element is moved through the atmospheric air.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

09/914327
JC03 PCT/PTO 27 AUG 2001
PCT/DK00/00094

A method and an apparatus for measuring icing

The present invention relates to a method and an apparatus for local measurement of an icing factor for atmospheric air containing supercooled water.

Such measurement are used in particular - but not exclusively - within the fields of aviation and navigation, wherein icing can constitute a substantial safety hazard when it comes to wrecking.

The problem arises as a result of atmospheric precipitation, such as rain and mist, that has in its supercooled state a known propensity to freeze on to objects, such as hull and machine parts on vessels as well as aeroplanes.

Thus, in practise critical weather conditions have often necessitated manual observations with a view to forming an impression of the acute risk of icing, in order to enable warning of aeroplanes and vessels, if necessary.

It is a problem in this context that such manual observation is based on a subjective discretion, and that consequently a standardised value for the risk of icing is not accomplished. Thus, a warning based on such subjective discretion will be associated with a good deal of insecurity, and the person who receives the warning cannot readily form a reliable picture of the risk of icing, except by relying on the recommendation of the issued warning.

Accordingly, US patent No 4,730,485 and published NO patent application No 151,060 teach apparatuses configured

for carrying out a more standardised measurement of the amount of atmospheric precipitation.

Thus, US patent No 4,730,485 teaches a stationary measurement device configured for measuring wind velocity as well as wind direction, but it is also suitable for measurement of the current icing.

Published NO patent application No 151,060 discloses a stationary weighing apparatus for weighing an amount of atmospheric precipitation in the form of snow or ice that settles on a substantially horizontal weighing plate.

However, it is a problem in connection with these prior art devices that icing often occurs in situations when the air is relatively still, and that the icing factor measured by such devices are erroneous since only small amounts of ice are deposited on the devices.

It is a further problem in connection with the prior art device known from published NO patent application No 151,060 that atmospheric precipitation other than supercooled water may deposit on the weighing plate and thus an erroneous weighing results in relation to the icing factor.

It is therefore the object of the present invention to provide a method and an apparatus whereby it is possible, in almost all weather conditions, in particular also light winds and still air, to provide a standardised measurement result or a standardised value for the icing factor.

This is achieved with the present invention by the method according to claim 1, or by use of an apparatus according to claim 7.

The method according to the present invention is thus characterised in comprising the following process steps:

providing at least one surface element made of a material suitable for ice in atmospheric air to freeze there on, said element having a predetermined surface area;

tempering the surface element(s) to a temperature that corresponds essentially to the temperature of the atmospheric air, following which a relative movement is produced with a predetermined velocity between the atmospheric air and the surface element(s), preferably by moving the surface element(s) through the atmospheric air, and at a predetermined period of time, and wherein the thickness or mass of the ice frozen fast onto the surface element is subsequently measured by means of a measurement device intended therefor.

This means, on the one hand, that atmospheric precipitation other than supercooled raindrops or mist can only with difficulty settle on the surface elements and adversely influence the measurement results, and that it is hereby possible to perform relatively accurate measurements of the icing factor, also in relatively still air.

In case the factor measured is the thickness of the ice layer, it is advantageous - to obtain a representative value therefor - to measure in a number of points, preferably in one or more points on each surface element, the

measurement results subsequently being summarised to a single value.

The value thus measured for the thickness of ice layer or weight increase will be a standardised factor that indicates a relative risk of icing of eg aeroplanes or vessels in the area in which measurement is performed. It goes without saying that the value can only be indicative of the risk since, obviously, it will vary more or less compared to the place where the measurement was performed.

The method can advantageously be exercised by use of an apparatus as featured in claim 7, said apparatus comprising at least a surface element made of a material suitable for ice in atmospheric air to freeze there on, and said surface element having a predetermined surface area, and wherein the apparatus further comprises means that are configured for moving the surface element through the atmospheric air at a predetermined velocity and for a predetermined period of time; and wherein means are also provided that are configured for measuring the thickness or the mass of the ice frozen fast onto the surface element after lapse of the predetermined period of time during which the surface element is moved through the atmospheric air.

According to a preferred embodiment of the method, it is ensured that frozen-on ice, if any, is removed prior to a first measurement, and likewise the frozen-on ice is removed from the individual surface element following measurement of its mass or thickness, whereupon a renewed measurement process can be performed. Advantageously, such removal of the ice can be accomplished by heating of

the individual surface elements either from the outside or from the inside.

Further advantageously, uniform measurement results are accomplished if a cover is provided that extends at least across the surface element, and covers and shields the surface element, and said cover being removed from the surface element at least for the predetermined period of time during which the surface element is moved through the atmospheric air at a predetermined velocity.

The accuracy of measurement is further enhanced if the surface element is moved through the atmospheric air at a velocity that ensures that atmospheric precipitation that does not freeze on to the surface element is to a substantial extent thrown off the surface element.

In order to ensure that the inside of the cover is protected against atmospheric precipitation settling thereon, it can advantageously be so arranged in its second position that its inside is protected against atmospheric precipitation. It is hereby ensured that atmospheric precipitation cannot drip from the inside of the cover and onto the surface elements when the cover is conveyed across same.

In order to ensure that the surface elements are essentially free of other atmospheric precipitation prior to the amount thereof being determined, they can advantageously be rotated for a predetermined period of time following return of the cover to its first position.

According to a particularly simple method, at least two surface elements are used that are rotatably arranged on

a rotor shaft whereby the movement of the two surface elements is effected by a rotation thereof about the rotor shaft.

According to a particularly simple embodiment, the apparatus comprises a weighing device configured for weighing and recording at least the weight of the surface element prior to and after movement of the surface element through the atmospheric air.

According to a particularly simple embodiment the apparatus comprises a rotor with a rotor shaft, and at least two surface elements that extend from the rotor shaft and protrude there from, and wherein means are configured for rotating the rotor about its axis. Hereby it is obtained that the movement mechanisms that bring about the movement of the surface elements through the air can be accomplished in a very simple manner that does not require maintenance.

Besides, with a view to also obtaining an increased accuracy of measurement the apparatus can also comprise a cover that is configured for assuming a first position in which it extends across the surface element, and thereby covers this upwardly, and a second position in which the cover has been removed from the surface element and does not cover same, and this cover is preferably configured such that in its first position, it forms a closed space around the surface element.

In order to be able to perform measurements in quick succession, means are conveniently provided that are, on the one hand, able to heat the surface elements in order to melt the ice deposited thereon, and on the other, to cool

them to approximately ambient temperature. This can be obtained in that the surface elements are configured with passageways; and that the apparatus comprises means whereby air can be conveyed through the passageways either in the form of heated air or air with approximately ambient temperature. Heating and cooling of the surface elements can also be accomplished by the closed space underneath the cover being heated and cooled.

It is desirable that the ice formation on the surface elements is as comprehensive as possible to ensure accuracy and speed of measurement, and consequently the surface element will, in a first preferred embodiment, be in the form of a plate with a front and a back which have opposite orientations relative thereto; and wherein the plate is configured in such a manner that the front of the plate faces in the direction in which the surface element is moved through the atmospheric air; and wherein - through said plate - a plurality of passageways are provided from the front of the plate to the rear of the plate, whereby atmospheric air is able to flow through the passageways from the front of the plate to the back of the plate.

According to an alternative, preferred embodiment the apparatus comprises a system of surface elements mounted on a rotatable shaft configured for being arranged in a substantially vertical position. The individual surface elements are configured and arranged such that the individual surface elements will, in correspondence with their projection on a face perpendicular to the rotatable axis, abut on or overlap other surface elements, which means that there is no space between the individual surface elements when the apparatus is viewed from above. Hereby

it is obtained that all atmospheric precipitation within the expanse of the apparatus hits the surface elements and thus can be deposited in the form of ice. The larger the overlap between the individual surface elements, the larger the deviation from vertically falling precipitation can be tolerated while ensuring this.

In correspondence with the above teachings, the surface elements can advantageously be configured and arranged such that the individual surface elements corresponding to their projection on a face parallel with the rotatable axis abuts on or overlaps other surface elements, so as to accomplish that there is no space between the individual surface elements when the apparatus is viewed from the side. Hereby it is obtained that the atmospheric air conveyed across the surface elements by the relative movement between the atmospheric air and the surface elements hits a surface element and is thereby able to deposit the water contained therein in the form of ice.

In case of embodiments like the ones described above, it is ensured that the apparatus can be configured with the smallest possible physical dimensions.

The apparatus according to the present invention is particularly suitable for use in airports, where the apparatus is preferably arranged at ground level in an air port, and whereby the apparatus comprises means for recording the measured results of the thickness or mass of the ice deposited on the surface elements, and means for visually or auditively emitting a signal regarding the measurement results to the monitoring personnel of the airport.

The invention will now be described in further detail with reference to the drawings, wherein

Figures 1 through 4 are explanatory sketches using a schematically represented apparatus to illustrate various process steps according to the present invention;

Figure 5 is a sectional view that illustrates a vertical, sectional view through a surface element for use in the apparatus according to the present invention;

Figures 6 through 8 show a first, preferred embodiment of an apparatus according to the invention, wherein the cover is shown in different positions;

Figure 9 shows an alternative, preferred embodiment of an apparatus according to the invention, seen from the side;

Figure 10 is a vertical, sectional view through the apparatus shown in Figure 9 corresponding to the plane indicated by B-B;

Figure 11 illustrates a preferred embodiment of a rotor element for use in connection with the invention;

Figure 12 is a top plan view of the rotor element corresponding Figure 11; and

Figure 13 shows a further preferred embodiment of a rotor element for use in connection with the invention.

Thus, Figure 1 shows the constructive principles of an apparatus according to the invention, said apparatus comprising a housing or a frame 1, in which a shaft or a ro-

tor 2 is arranged that supports two diametrically opposed surface elements 3, and that are rotated by a drive unit 4 in the direction of the arrow A. The rotor with one or more surface elements is also referred to as the rotor element.

Corresponding the normal operative state of the apparatus, the shaft or the rotor is configured for being arranged in a substantially vertical position. When, in the following, the terms vertical and horizontal are used, they refer to the apparatus when arranged in such preferred position.

Additionally the apparatus comprises a weighing device 5 configured for weighing the surface elements 3, the rotor 2 and the drive unit 4, whereby a weight increase can be determined.

Besides, the apparatus comprises a movable cover, in Figures 1 through 4 shown as a dome-shaped shield consisting of two spherical quarter shells 6 that are shown in Figure 1 in a first position in which they shield the surface elements 3 and the rotor 2 and form a substantially closed space 7 around the surface elements and the rotor.

Moreover, the apparatus comprises a blower 8 configured for conveying atmospheric air towards the surface elements 3.

In the process step shown in Figure 1, the rotor is thus rotated in the closed space 7, and as a consequence of the blower 8 generating circulation of air in that space, the surface elements 3 are caused to assume a temperature that corresponds essentially to the ambient temperature.

Now, Figure 2 illustrates a subsequent process step in which the two spherical quarter shells 6 have been withdrawn to a second position in which the surface elements 3 on the rotor 2 rotate in the open air, and wherein - provided supercooled water is present in the air - ice formations will settle on the surface elements 3. It will appear from the figure that the cover in its second position is situated within the housing that is advantageously configured such that inside of the cover is protected against atmospheric precipitation settling thereon. In the embodiment shown, this could only be accomplished by the spherical shells of the cover being conveyed down into the housing through a narrow opening between the top face and lateral walls of the housing. Such configuration ensures that atmospheric precipitation cannot drip from the inside of the cover and down onto the surface elements when the cover is conveyed above them.

In accordance with the invention, the process step shown in Figure 2 is carried out for a predefined period of time, whereby a suitable amount of ice will deposit on the surface elements, and the rotor is rotated at a velocity that, on the one hand, takes into account that the ice is not to be thrown off the rotor, but wherein other precipitation, if any, in the form of rain and snow is thrown off to a suitable extent. As shown in the figure, it is of course to be ensured that the cover can be conveyed past the various structures of the housing.

Advantageously, the weighing device can be configured with three weighing cells situated triangularly between the drive unit 4 and the lower part of the housing.

Hereby a stable determination of weight for the drive unit, the rotor, the surface elements and the ice frozen thereon is obtained.

Following the process step shown in Figure 2, a subsequent step is shown in Figure 3 wherein the cover has been returned to its first position. In order to ensure that the surface elements are substantially free of atmospheric precipitation other than ice before the amount thereof is determined, they can advantageously be rotated for a predetermined period of time after the cover has reverted to its first position.

Now the surface elements are brought to a halt, and the weight increase of the surface elements resulting from the ice deposited on its surfaces is recorded by means of the weighing device 5, and on the basis of the value measured, a signal can be generated for showing an icing factor; however, the drawing does not feature equipment for this use since it will be obvious to the person skilled in the art to configure such equipment on the basis of the present description.

Now a subsequent process step is shown in Figure 4 wherein the two spherical quarter shells 6 have been moved across the surface elements 3 and shield them so as to form yet again the closed space 7. In this process step the rotor is caused to rotate, and a quick heating of the closed space 7 is carried out by means of the blower 8 and a heater element 9 whereby the ice deposited on the surface elements is melted and thrown off by the rotation of the rotor, whereby the combined weight of the rotor 2 and the surface elements 3 is caused to revert to the initial weight.

Now the process step shown in Figure 1 can proceed, and the apparatus according to the invention is thus very suitable for carrying out repeated measurements with a very high degree of accuracy in standardised conditions.

In order to obtain the highest possible accuracy of measurement, the surface elements 3 should be configured with the largest possible surface for adhesion of ice. Figure 5 illustrates an embodiment wherein a surface element is constructed as a grid, as seen in a vertically sectional view through this, and from which it will appear that the surface element that is moved in the direction of the arrow B has a front 13 and a back 14; and wherein walls 11,12 combine to form passageways 10 that extend from the front 13 to the back 14.

Hereby the surface element forms a relatively large surface compared to the indigenous weight of the surface element which means that a relatively quick formation of a suitable and measurable amount of ice is accomplished on the surfaces of the surface element 3, and such that the surface element can quickly be caused to assume the desired temperatures by the heating as shown in Figure 4 and the cooling as shown in Figure 1.

Both walls 11,12 having a downwardly tapering course means that, on the one hand, atmospheric precipitation other than supercooled water or mist is very like to slide or flow off the surface element 3, but also that supercooled water droplets or mist are very like to settle on the surfaces of the surface element without having to pass all the way through the surface element.

The surface elements shown in Figures 1 through 4 are, for the sake of clarity, shown to be very small, but according to a preferred embodiment they are dimensioned to essentially fill the space 7, which means that the surface elements as shown in Figures 1 through 4 join to constitute an approximate semicircle. Hereby it is ensured that the apparatus can be configured with the smallest possible outer dimensions.

As described above, it should be ensured that the inside of the cover is protected against atmospheric precipitation in all process steps; and this is to ensure accurate determination of the amount of ice frozen fast there on.

Figures 6 through 8 show an embodiment in which an apparatus comprises a housing 1, a cover in the form of two spherical quarter shells 6, two storage units 41 for the two spherical quarter shells and a platform 40 on which the storage units have been arranged. Furthermore the apparatus comprises a rotor element, a drive unit and a (not shown) weighing device as described above.

In a first position the cover 6A covers the rotor element and forms a substantially closed space; in Figure 6 this is outlined with dotted lines. When it is desired to perform a measurement, the elements of the cover are, as shown in Figures 6, 7 and 8, moved to their second position where they are stored for protection in the storage units 41. Since it is in particular the inside of the cover that is to be protected against atmospheric precipitation, it can be chosen to allow the storage units to be upwardly open, which would simplify the construction. Once the first part of the measurement is accomplished the cover reverts to its first position.

Above it has be outlined schematically how protection of the cover inside against the weather can be accomplished, but of course it is possible to select the configuration, shape and the mutual relations of the cover and the storage units on the basis of many considerations.

Figure 9 shows a further embodiment wherein the apparatus comprises a housing 101 with a drive unit, a frame 110, a control unit 115, a cover 106, and a rotor element 103. The housing 101 is configured as a closed and approximately semicylindrical object cut-off in correspondence with the cylinder axis; the housing is mounted in a frame 110 such that the cylinder axis is substantially embedded horizontally. The cover 106 is also configured as approximately as a semicylinder cut-off in correspondence with its cylinder axis and open in correspondence with the cut edge. The cover is mounted on the frame 110 in such a manner that the cylinder axis of the cover essentially coincides with the cylinder axis of the housing. The cover is configured with a width that is wider (corresponding to the length of the cylinder axis) and a cylinder radius that is larger than the housing, and pivotally mounted on the frame such that the cylinder axis of the cover also constitutes its axis of rotation. This configuration of the cover and housing makes it possible for the cover, upon a 180 degree rotation about its axis of rotation, to be conveyed from its first position as shown in Figure 9 to a second position underneath the housing, and such that the housing is essentially enclosed in the cover. In Figure 9, the end face of the cover towards the viewer has been removed such that the rotor element 103 arranged on top of the housing is visible. When the cover is turned away as described above,

the rotor element will be uncovered and a measurement can be initiated. As also described above, this device will ensure that the inside of the cover is protected against atmospheric precipitation while in its second position.

Study of Figure 10 will now reveal a section through the apparatus shown in Figure 9 corresponding to the plane indicated by B-B. As will appear, the housing is - by means of two fittings 112,113 - mounted in a frame consisting of two posts 110,111. As described above, the housing as well as the cover are mounted with their respective cylinder axes about a common axis 102. The rotor element 103 comprises a rotor shaft 120 and a system of surface elements of which only the top 121 and bottom ones are shown. The overall cylindrical shape of the rotor element is outlined with dotted lines. In the space 107 between the cover and the housing, a sealing is advantageously arranged whereby it is prevented both that atmospheric precipitation penetrates into the space between the cover and the housing and that the atmospheric precipitation that has found its way to the space, if any, will be removed from the inside of the cover when it is conveyed from its second to its first position. As shown in Figures 9 and 10, the top face of the housing is configured as an upwardly conical face, whereby it is ensured that eg melt water is, upon heating of the surface elements, conveyed away from the housing and in particular away from the rotor shaft passage.

Between the posts a control unit 115 is arranged for controlling the drive unit 104, the weighing unit 105, the blower 108, and the heater element 109, and for collection, storage and optionally transmission of measurement data. Such units are configured for functioning in a man-

ner similar to the one described above with reference to Figures 1 through 4. In Figure 10 it is indicated that air is, by means of the blower 8, blown into the rotor shaft and from there conveyed out through the surface elements as also described above. Between the top part of the housing and the rotor shaft, a (not shown) bearing device can advantageously be arranged for supporting and guiding the shaft. According to a preferred embodiment, the apparatus further comprises (not shown) means for automatically shifting the cover between its first and second positions. Obviously, the apparatus comprises a device for securing the cover in its first position; preferably also in its second position.

A preferred embodiment of a rotor element for use in an apparatus according to the invention will now be described with reference to Figures 11, 12 and 13.

In Figure 11, the rotor element comprises a shaft 20 on which four stacks are arranged that each consists of a number of surface elements arranged at a mutual distance opposite each other with the respective top surface elements 21,22,23,24 arranged in an uppermost plane. Each surface element has a free outer end and an inner end secured to the shaft. The uppermost face elements are arranged with a constant mutual angular distance that corresponds to an angle of 90 degrees as far as four top surface elements are concerned.

As will appear from the figure, the surface elements in the individual stack are displaced relative to each other with the outer free ends arranged so as to generally form a helix. For each stack this helix extends at least over an angle corresponding to the angle between two succes-

sively arranged stacks. For an embodiment with four stacks a helix thus extends over at least 90 degrees. In a particular case where only one stack is used, such stack will be able to extend a full rotation about the shaft, ie 360 degrees.

The individual surface elements are configured and arranged such that, in correspondence with their projection on a horizontal face, they overlap the surface element(s) that are adjacent to or arranged between, respectively, the individual surface elements, so as to eliminate spaces between the individual surface elements when the apparatus is viewed from above. This is shown in Figure 12 that illustrates the apparatus according to Figure 11, seen from above. Hereby it is obtained that atmospheric precipitation falling within the expanse of the apparatus hits the surface elements and is thus able to settle in the form of ice. The larger the overlap between the individual surface elements, the larger a deviation from vertically falling atmospheric precipitation can be tolerated, while ensuring this.

In correspondence with the above teachings, the surface elements in the embodiment shown can advantageously be configured and arranged such that the individual surface elements corresponding to their projection on a vertical face abut on or overlap the surface elements (5) that adjoin or surround, respectively, the individual surface element so as to eliminate a space, if any, between the individual surface elements when the apparatus is seen from the side. Hereby it is obtained that the atmospheric air conveyed across the surface elements by the relative movement between the atmospheric air and the surface elements hits a surface element and is thereby able to de-

posit the water contained therein as ice. This is in accordance with the disclosures above with reference to Figure 5.

In an embodiment as shown in Figures 11 and 12 it is further ensured that the apparatus can be configured with the smallest possible outer dimensions. For instance, an embodiment with four stacks of each eleven surface elements and a diameter of 70 cm has proven to be convenient.

As will also appear from Figure 11, the individual surface elements are provided with a number of passageways 25 through which air can be blown, heated air to deice the surface elements and air with ambient temperature for tempering the surface elements prior to the next measurement, respectively. According to a convenient embodiment the air is conveyed from the basis of the apparatus to the surface elements through the shaft 20.

In accordance with the embodiment shown in Figure 11, the surface elements are attached only to the shaft 20 in correspondence with their one end, and this is why the individual surface element is dimensioned to support itself and resist the forces that will occur during the intended use of the apparatus. In an alternative embodiment shown in Figure 13, a large number of rather thin surface elements are used that will be secured partly in correspondence with their inner end to the shaft, partly secured with their outer end to a support structure. This support structure comprises an upper support element 30 secured to the shaft by means of upper connecting means 31 and a lower support member 32 secured to the shaft by means of lower connecting elements 33. Between the upper

and the lower support elements a number of outer support elements 34 are arranged, to which the outer end of the surface elements are secured. Corresponding to the above-described embodiment, four stacks of surface elements are also used herein that are in a corresponding manner supported by four outer support elements 34.

Corresponding to the embodiment shown in Figure 11, the surface elements have equal lengths, which means that each helix extends in a manner that corresponds to the surface of a cylinder and, likewise, the overall shape of the rotor element will be cylindrical. In the alternative embodiment shown in Figure 13, for each stack surface elements are used that have decreasing length towards the top of the apparatus; if the length decreases linearly the individual outer support element 34 will have a course corresponding to a helix on the surface of a cone, and - likewise - the overall shape of the rotor element will in that case be a cone. As stated above, the overall shape and dimensions of the rotor element and the cover will conveniently correspond to each other. For an embodiment of the apparatus like the one shown in Figures 6 through 8, the rotor element should thus be semispherical.

Of course, it is possible in case of both the described embodiments to arrange surface elements such that the helix-shape described is not a 'perfect' geometrical helix but merely what the person skilled in the art describes as "spiral-shaped".

Obviously, on the basis of the above explanation of the principle underlying the invention, the person skilled in the art will readily be able to point to various embodi-

ments of the construction of an apparatus that is able to perform said process steps as well as to identify process parameters that are suitable therefor with due regard to the configuration of the apparatus, such as the period of time during which the surface elements are to be moved through the open air as shown in Figure 2, and the rate at which the surface elements 3 are to be moved through the air in order to obtain suitable measurement results that are not considerably influenced in case atmospheric precipitation other than supercooled water and mist is deposited on the surface elements 3. Obviously, there is a correlation between the configuration of the apparatus itself and the operation parameters that ensure that the desired measurement results are obtained.

C l a i m s

1. A method for local measurement of an icing factor for atmospheric air containing supercooled water, characterised in that the method comprises the following process steps:

wherein at least one surface element (3) is provided that is made of a material suitable for ice in atmospheric air to freeze on, said element having a predetermined surface area;

wherein the surface element(s) is/are brought to a temperature that corresponds essentially to the temperature of the atmospheric air;

wherein a relative movement at a predetermined velocity is subsequently created between the atmospheric air and the surface element(s), preferably by allowing the surface element(s) to move through the atmospheric air, and for a predetermined period of time;

and wherein the thickness or mass of the ice frozen fast to the surface element(s) is subsequently measured by means of a measurement device configured therefor.

2. A method according to claim 1, characterised in that the ice frozen fast is, following measurement its mass or thickness, removed from the surface element(s), whereupon a renewed measurement process can be performed.

3. A method according to claim 2, characterised in that the ice frozen fast is removed by heating of the surface element(s).

4. A method according to one of the preceding claims, characterised in that a cover is provided that extends at least across the surface element(s), and covers and shields the surface element(s); and said cover being removed from the surface element(s) at least for the predetermined period of time during which the surface element(s) is/are moved through the atmospheric air at a predetermined rate.

5. A method according to claim 4, characterised in that the surface element(s) is/are caused to move for a predetermined period of time after the cover has reverted to its first position following a measurement procedure, whereupon the thickness or mass of the ice frozen fast on the surface element(s) is measured.

6. A method according to any one of the preceding claims, characterised in that the surface element(s) are caused to move through the atmospheric air at a velocity that ensures that atmospheric precipitation not frozen fast onto the surface element(s) is substantially thrown off the surface element(s).

7. A method according to any one of the preceding claims, characterised in that at least two surface elements are used that are rotatably arranged on a rotor shaft; and that the movement of the two surface elements is accomplished by a rotation of the rotor shaft.

8. An apparatus for local measurement of an icing factor for atmospheric air containing supercooled water, characterised in that the apparatus comprises at least a surface element (3) made of a material suitable for ice in atmospheric air to freeze on, wherein the surface element(s) has/have a predetermined surface area, and wherein the apparatus further comprises means (4) configured for moving the surface element(s) through the atmospheric air at a predetermined rate and for a predetermined period of time, and wherein further means (5) are provided for measuring the thickness or mass of the ice frozen fast onto the surface element(s) after the predetermined period of time, during which the surface element(s) has/have been moved through the atmospheric air.

9. An apparatus according to claim 8, characterised in comprising a weighing device (5) configured for weighing and recording at least the weight of the surface element(s) before and after the surface element(s) is/are caused to move through the atmospheric air; and that the apparatus preferably comprises means for heating the surface element(s).

10. An apparatus according to claim 8 or 9, characterised in that the apparatus comprises a rotor element with a rotor shaft (2), and at least two surface elements (3) that extend from the rotor shaft and protrude there from, and wherein means (4) are provided for rotating the rotor abut its axis.

11. An apparatus according to any one of claims 8 through 10, characterised in that the apparatus comprises a cover (6) whose inside faces towards the surface elements and which is configured for occupying a first position in

which it extends across the surface element(s) that is/are hereby covered upwardly, and a second position in which the cover is removed and does not cover the surface element(s).

12. An apparatus according to claim 11, **characterised in** that the cover is configured such that it forms, in its first position, a closed space (7) around the surface element(s).

13. An apparatus according to claim 12, **characterised in** that means (8,9) are provided for heating the closed space underneath the cover.

14. An apparatus according to any one of claims 11 through 13, **characterised in** that the apparatus is configured for moving the surface element(s) for a predetermined period of time after the cover (6) has, following a measurement procedure, reverted to its first position, whereupon the thickness or mass of ice frozen fast can be determined.

15. An apparatus according to any one of claims 11 through 14, **characterised in** that the cover is, in its second position, positioned such that its inside is substantially protected against atmospheric precipitation and consequently remains dry.

16. An apparatus according to any one of claims 8 through 15, **characterised in** that the surface element(s) each consists of a plate having a front (13) and a back (14) oriented opposite thereto, and wherein the plate is configured in such a manner that the front of the plate faces in the direction in which the respective surface

element is moved through the atmospheric air, and wherein - through the plate - a plurality of passageways (10) extend from the front of the plate to its back such that the atmospheric air is allowed to flow through the passageways from the front of the plate to the back of the plate.

17. An apparatus according to any one of claims 8 through 16, characterised in that the apparatus comprises a system of surface elements (21,22,23,24) mounted on a rotatable shaft (20) configured for being positioned in an essentially vertical position; and wherein the individual surface elements are configured and arranged such that the individual surface elements, corresponding to their projection on a face perpendicular to the rotatable shaft, abuts on or overlaps other surface elements, whereby it is accomplished that there is no space between the individual surface elements when the apparatus is viewed from above, and thus that all atmospheric precipitation falling within the expanse of the apparatus, when the rotatable shaft is positioned vertically, essentially hits the surface elements and is thus able to settle in the form of ice.

18. An apparatus according to claim 17, characterised in that the surface elements are configured and arranged such that the individual surface elements corresponding to their projection on a face parallel with the rotatable shaft (20) abuts on or overlaps other surface elements, whereby there is no space between the individual surface elements, when the apparatus is viewed from the side, and such that the atmospheric air conveyed across the surface elements in a direction substantially perpendicular to the shaft by a relative movement between the atmospheric

air and the surface elements substantially hits a surface element and is thus able to deposit the water contained therein as ice.

19. An apparatus according to any one of claims 8 through 18, characterised in that the surface elements are configured with passageways; and that the apparatus comprises means such that air can be conveyed through the passageways, preferably in the form of either heated air or air essentially with ambient temperature.

20. An apparatus according to any one of claims 8 through 19, characterised in that the apparatus is arranged at ground level in an airport; and that the apparatus comprises means for recording the measurement results for the thickness or mass of the ice deposited on the surface element(s), and means for visually or auditively emitting a signal to the monitoring personnel about the measurement result, preferably by the apparatus comprising means that can convert the thickness or mass measured into a value that will be indicative of a risk of icing.

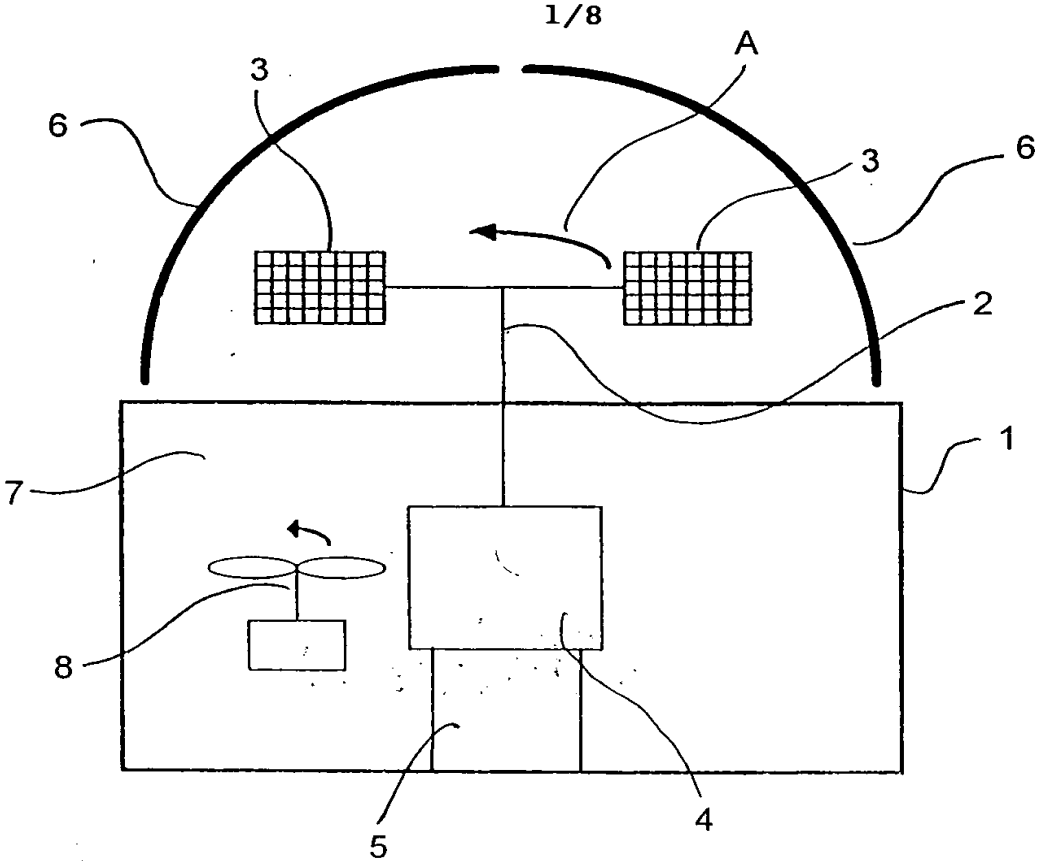


Fig. 1

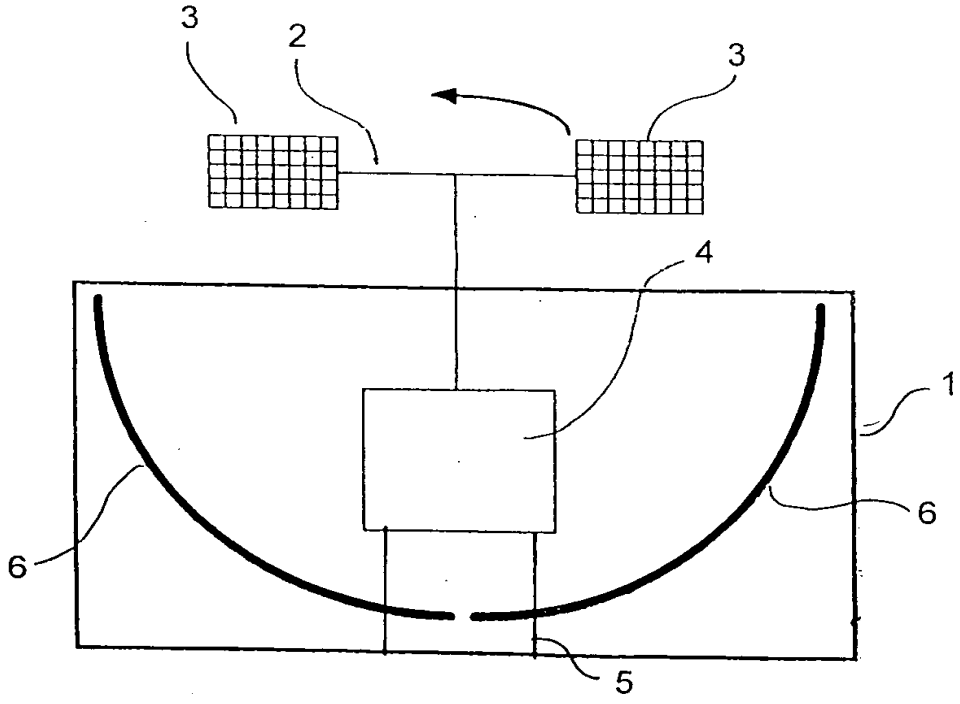


Fig. 2

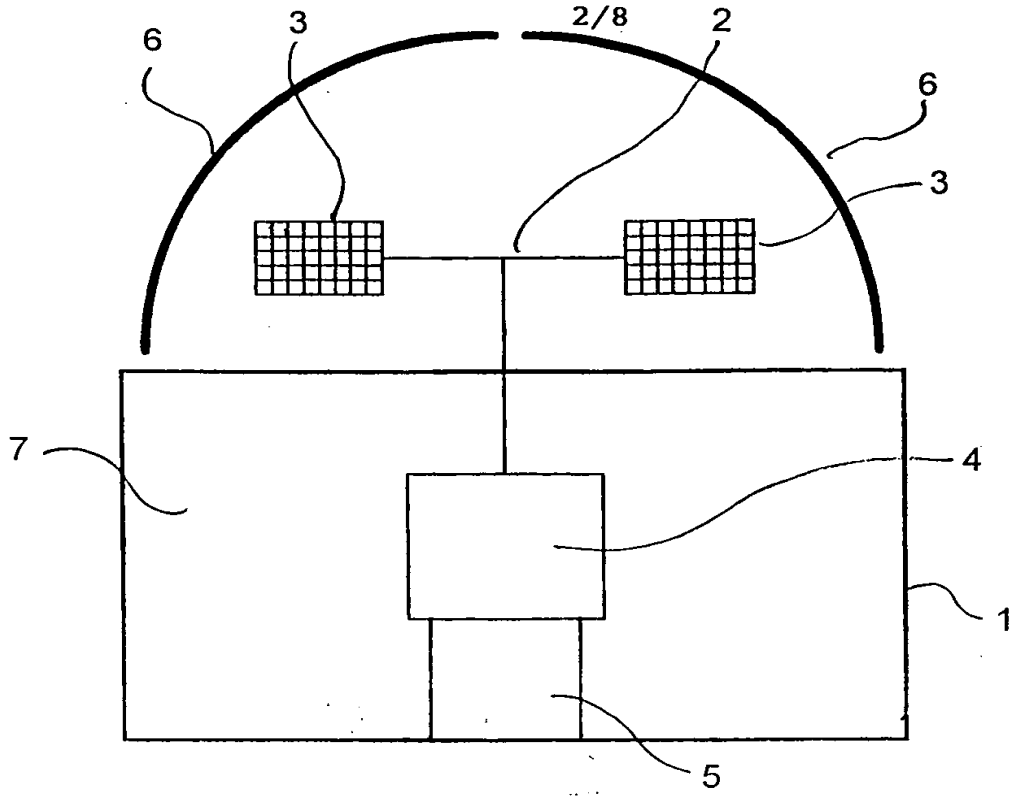


Fig. 3

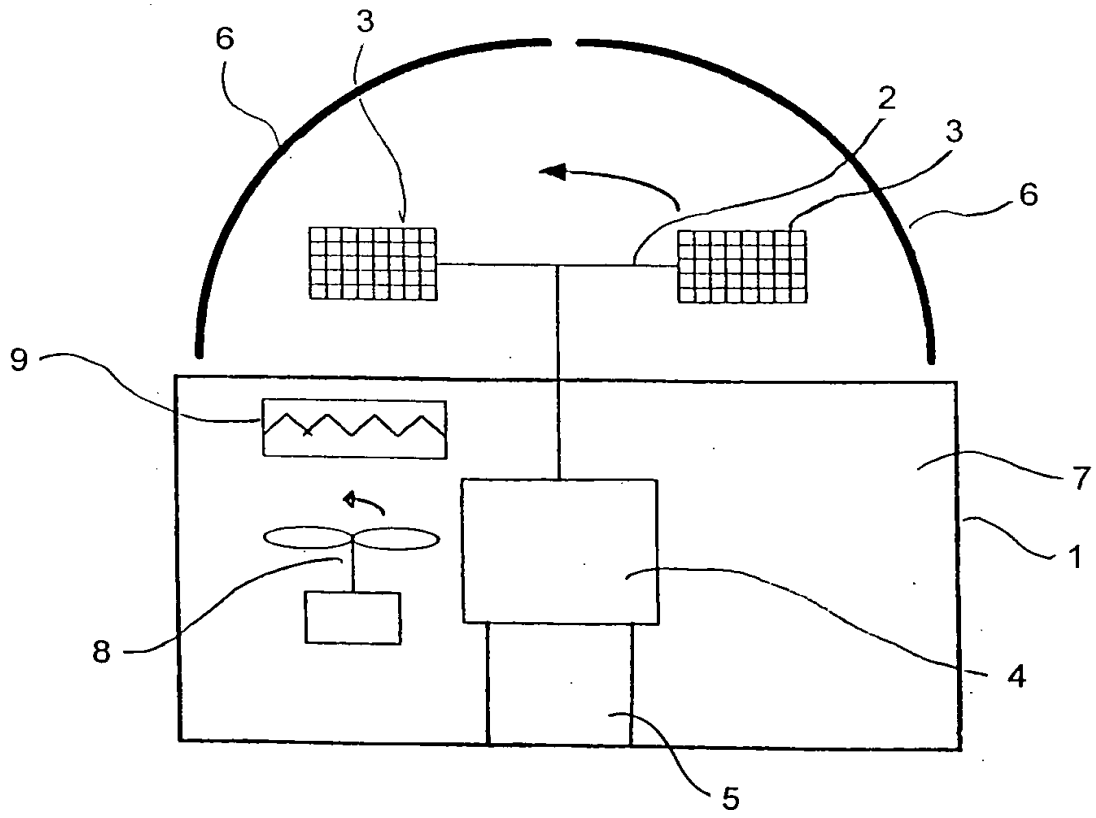


Fig. 4

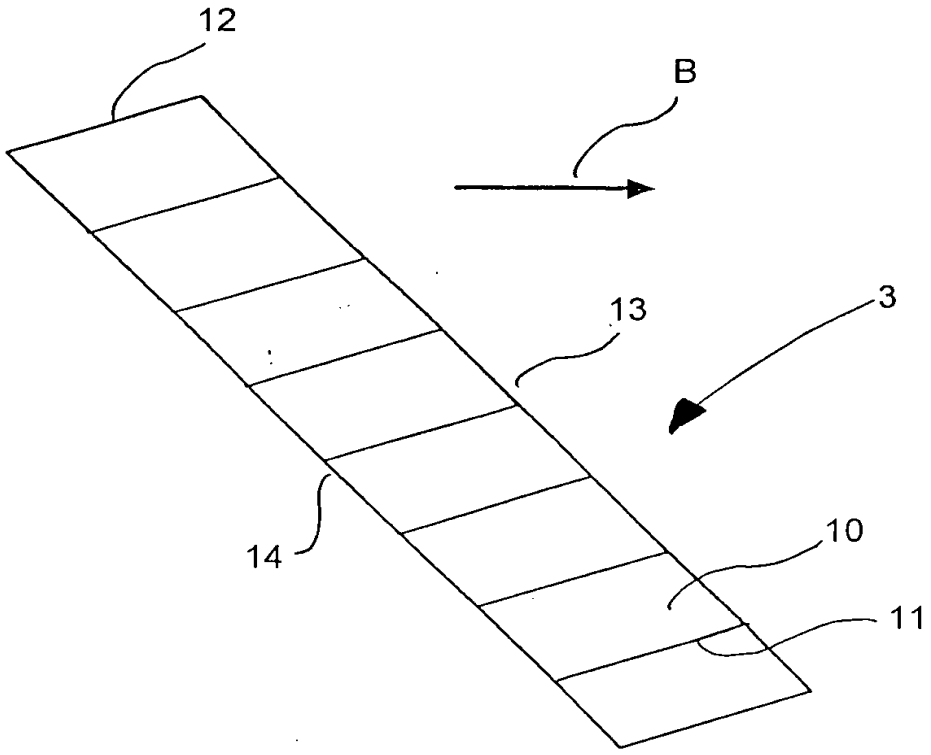


Fig. 5

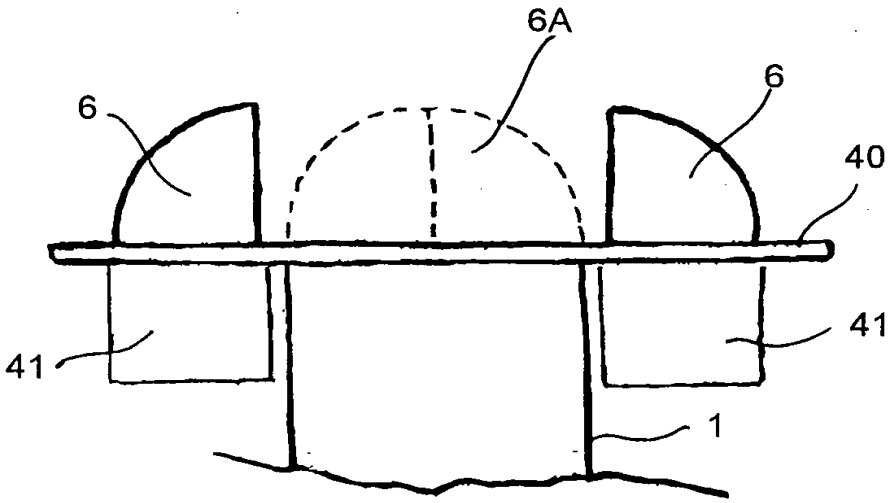


Fig. 6

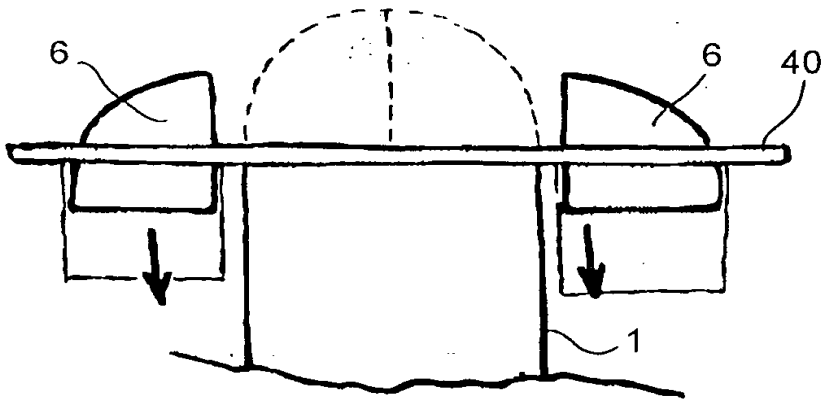


Fig. 7

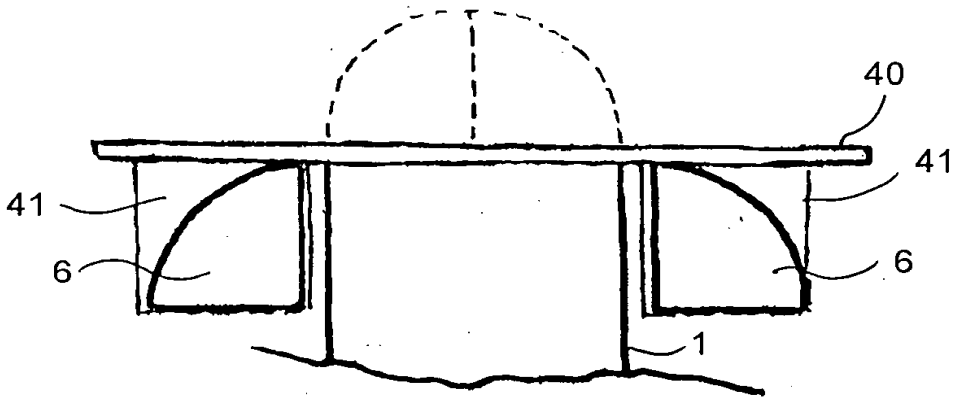


Fig. 8

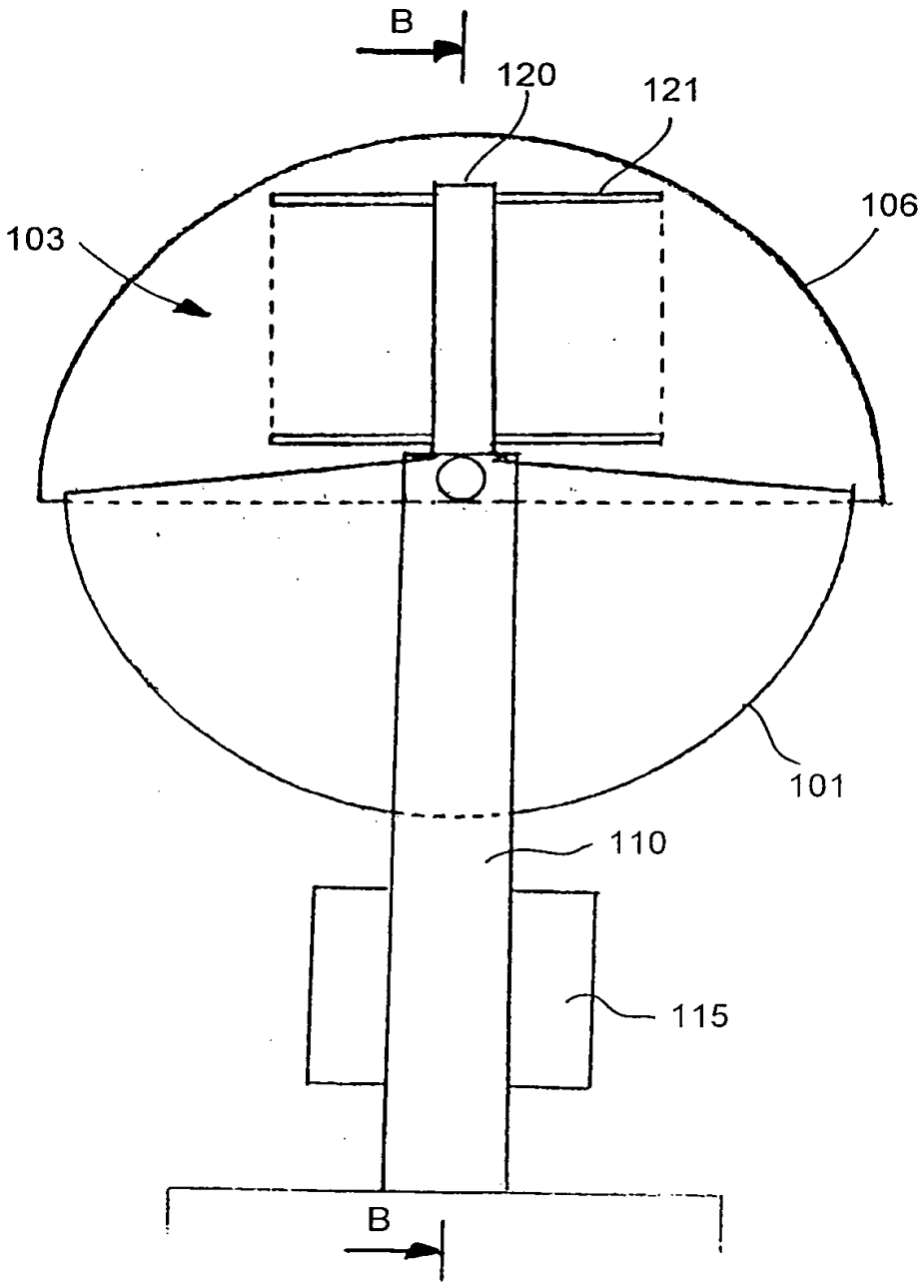


Fig. 9

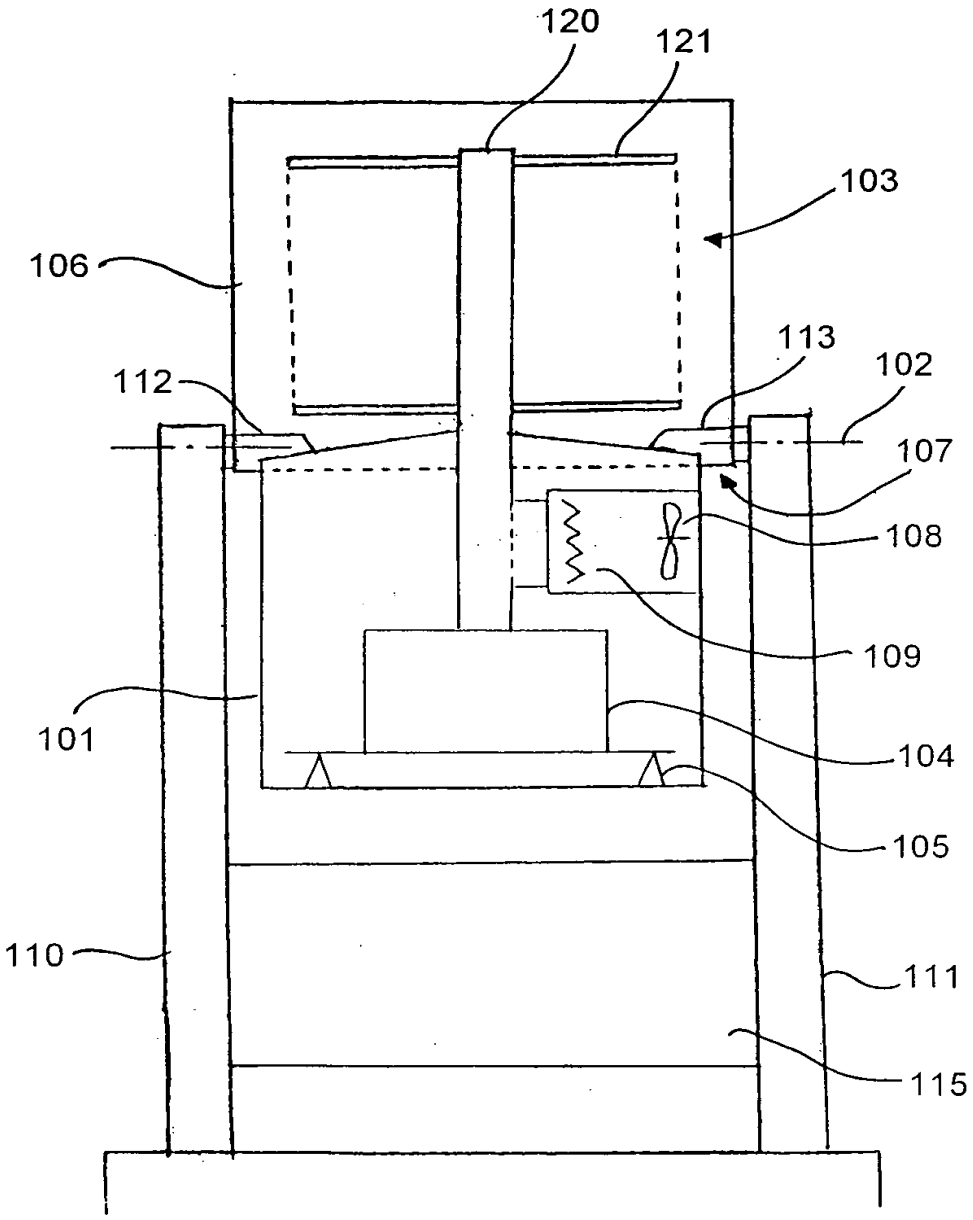


Fig. 10

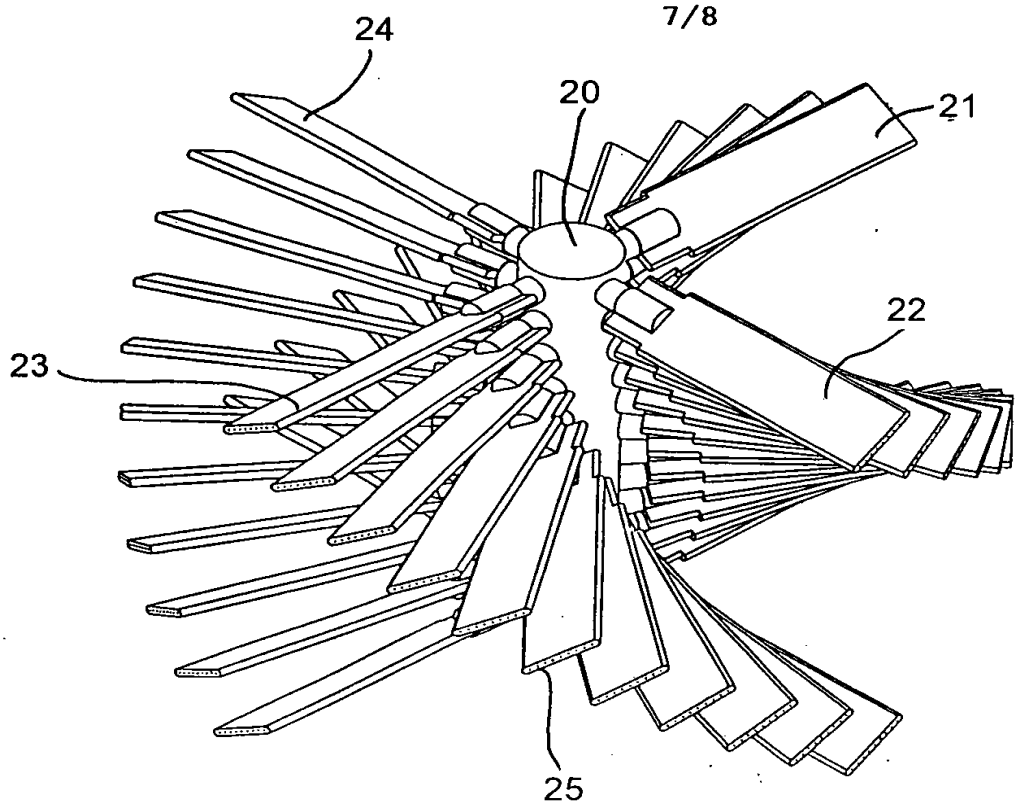


Fig. 11

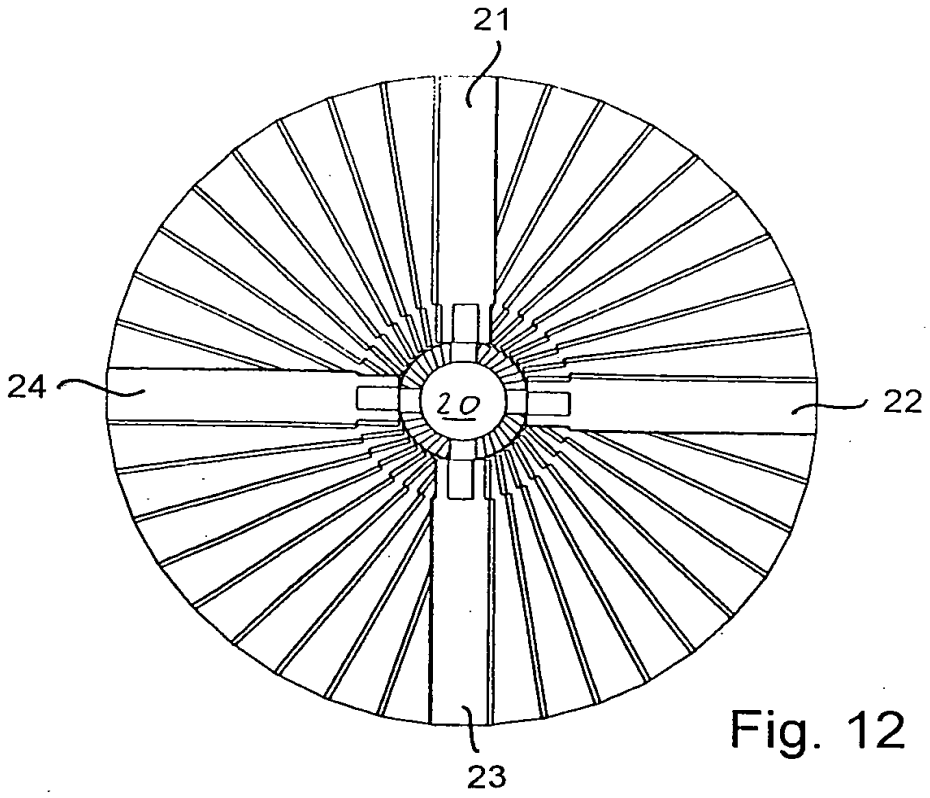


Fig. 12

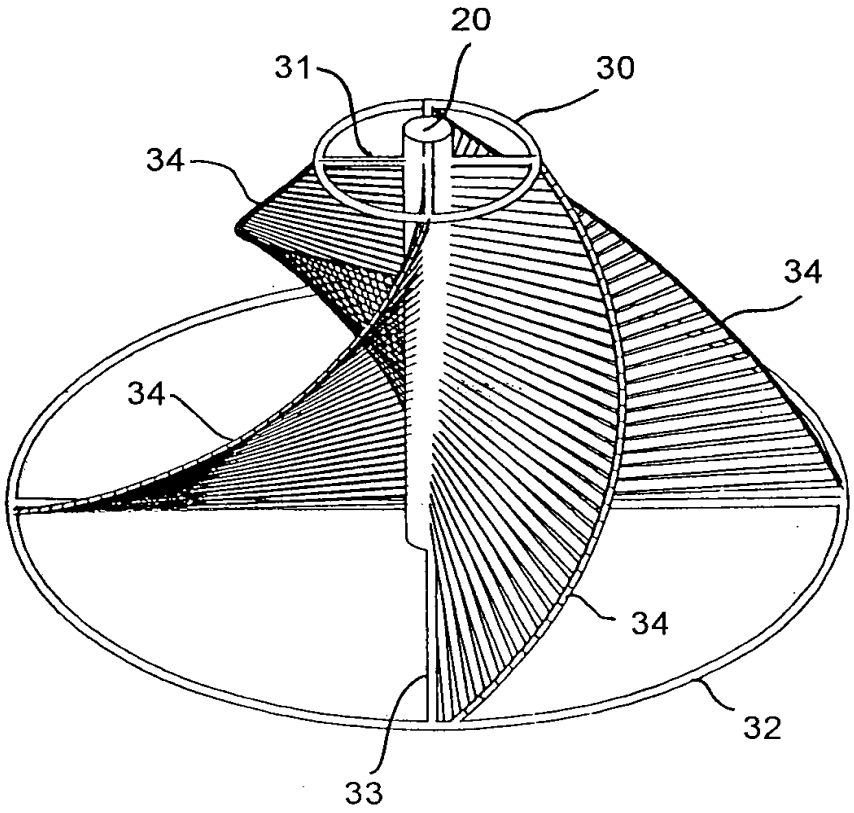


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00094

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01W 1/00, G01W 1/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01W, G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5317915 A (J.CHOISNET), 7 June 1994 (07.06.94), abstract ---	1-20
A	US 5003295 A (L.A.KLEVEN), 26 March 1991 (26.03.91), abstract ---	1-20
A	US 4730485 A (C.H.FRANKLIN ET AL), 15 May 1988 (15.05.88), abstract ---	1-20
A	US 4210021 A (N.A.VYKHODTSEV ET AL), 1 July 1980 (01.07.80), abstract ---	1-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
5 June 2000

Date of mailing of the international search report
20.07.00

Name and mailing address of the International Searching Authority
European Patent Office P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel(+31-70)340-2040, Tx 31 651 epo nl,
Fax(+31-70)340-3016

Authorized officer
Lars Jakobsson /itw
Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00094

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3940622 A (J.R.STALLABRASS ET AL), 24 February 1976 (24.02.76), abstract -- --------	1-20

SA 272346

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/DK 00/00094

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5317915 A	07/06/94	CA 2078521 A	19/03/93
		DE 4231303 A	25/03/93
		FR 2681310 A,B	19/03/93
		GB 2259895 A,B	31/03/93
		IT 1257153 B	05/01/96
		IT TO920770 D	00/00/00
US 5003295 A	26/03/91	CA 1300246 A	05/05/92
		DE 3883773 D,T	13/01/94
		EP 0374161 A,B	27/06/90
		IL 86581 A	08/07/93
		JP 2503953 T	15/11/90
		WO 8809941 A	15/12/88
US 4730485 A	15/05/88	NONE	
US 4210021 A	01/07/80	NONE	
US 3940622 A	24/02/76	CA 971652 A	22/07/75
		DE 2353105 A	02/05/74
		DK 151544 B,C	14/12/87
		FR 2204301 A	17/05/74
		GB 1406957 A	17/09/75
		IT 996874 B	10/12/75
		JP 996479 C	30/04/80
		JP 49134386 A	24/12/74
		JP 54029915 B	27/09/79
		NO 136568 B	20/06/77
		SE 394526 B,C	27/06/77

TENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P199900311 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/DK00/00094	07/03/2000	08/03/1999
International Patent Classification (IPC) or national classification and IPC G01W1/00		
Applicant NIELSEN, Evan		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 11 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
02/10/2000	22.03.01
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kunz, L Telephone No. +49 89 2399 2628

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/DK00/00094

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1,5-21	as originally filed			
2-4,4a	as received on	22/02/2001	with letter of	19/02/2001

Claims, No.:

1-23	as received on	22/02/2001	with letter of	19/02/2001

Drawings, sheets:

1/8-5/8,7/8,8/8	as originally filed			
6/8	as received on	22/02/2001	with letter of	19/02/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   ☐ the language of publication of the international application (under Rule 48.3(b)).
   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.
   ☐ filed together with the international application in computer readable form.
   ☐ furnished subsequently to this Authority in written form.
   ☐ furnished subsequently to this Authority in computer readable form.
   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 to 23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1 to 23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1 to 23
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

PAGE BLANK (USPTO)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00094

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01W 1/00, G01W 1/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01W, G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5317915 A (J.CHOISNET), 7 June 1994 (07.06.94), abstract --	1-20
A	US 5003295 A (L.A.KLEVEN), 26 March 1991 (26.03.91), abstract --	1-20
A	US 4730485 A (C.H.FRANKLIN ET AL), 15 May 1988 (15.05.88), abstract --	1-20
A	US 4210021 A (N.A.VYKHODTSEV ET AL), 1 July 1980 (01.07.80), abstract --	1-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
5 June 2000

Date of mailing of the international search report
20.07.00

Name and mailing address of the International Searching Authority
European Patent Office P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel(+31-70)340-2040. Tx 31 651 epo nl.
Fax(+31-70)340-3016

Authorized officer
Lars Jakobsson /itw
Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00094

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3940622 A (J.R.STALLABRASS ET AL), 24 February 1976 (24.02.76), abstract -- --------	1-20

SA 272346

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/DK 00/00094

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5317915 A	07/06/94	CA 2078521 A	19/03/93
		DE 4231303 A	25/03/93
		FR 2681310 A,B	19/03/93
		GB 2259895 A,B	31/03/93
		IT 1257153 B	05/01/96
		IT T0920770 D	00/00/00
US 5003295 A	26/03/91	CA 1300246 A	05/05/92
		DE 3883773 D,T	13/01/94
		EP 0374161 A,B	27/06/90
		IL 86581 A	08/07/93
		JP 2503953 T	15/11/90
		WO 8809941 A	15/12/88
US 4730485 A	15/05/88	NONE	
US 4210021 A	01/07/80	NONE	
US 3940622 A	24/02/76	CA 971652 A	22/07/75
		DE 2353105 A	02/05/74
		DK 151544 B,C	14/12/87
		FR 2204301 A	17/05/74
		GB 1406957 A	17/09/75
		IT 996874 B	10/12/75
		JP 996479 C	30/04/80
		JP 49134386 A	24/12/74
		JP 54029915 B	27/09/79
		NO 136568 B	20/06/77
		SE 394526 B,C	27/06/77

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00094

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3940622 A (J.R.STALLABRASS ET AL), 24 February 1976 (24.02.76), abstract -- --------	1-20

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
P199900311 WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/DK 00/ 00094	07/03/2000	08/03/1999
Applicant		
NIELSEN, Evan		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 9

   [X] as suggested by the applicant.

   [ ] None of the figures.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00094

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01W 1/00, G01W 1/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01W, G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5317915 A (J.CHOISNET), 7 June 1994 (07.06.94), abstract --	1-20
A	US 5003295 A (L.A.KLEVEN), 26 March 1991 (26.03.91), abstract --	1-20
A	US 4730485 A (C.H.FRANKLIN ET AL), 15 May 1988 (15.05.88), abstract --	1-20
A	US 4210021 A (N.A.VYKHODTSEV ET AL), 1 July 1980 (01.07.80), abstract --	1-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 June 2000	20.07.00

Name and mailing address of the International Searching Authority
European Patent Office P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel(+31-70)340-2040, Tx 31 651 epo nl,
Fax(+31-70)340-3016

Authorized officer
Lars Jakobsson /itw
Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/99

International application No.
PCT/DK 00/00094

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5317915 A	07/06/94	CA 2078521 A	19/03/93
		DE 4231303 A	25/03/93
		FR 2681310 A,B	19/03/93
		GB 2259895 A,B	31/03/93
		IT 1257153 B	05/01/96
		IT T0920770 D	00/00/00
US 5003295 A	26/03/91	CA 1300246 A	05/05/92
		DE 3883773 D,T	13/01/94
		EP 0374161 A,B	27/06/90
		IL 86581 A	08/07/93
		JP 2503953 T	15/11/90
		WO 8809941 A	15/12/88
US 4730485 A	15/05/88	NONE	
US 4210021 A	01/07/80	NONE	
US 3940622 A	24/02/76	CA 971652 A	22/07/75
		DE 2353105 A	02/05/74
		DK 151544 B,C	14/12/87
		FR 2204301 A	17/05/74
		GB 1406957 A	17/09/75
		IT 996874 B	10/12/75
		JP 996479 C	30/04/80
		JP 49134386 A	24/12/74
		JP 54029915 B	27/09/79
		NO 136568 B	20/06/77
		SE 394526 B,C	27/06/77

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P199900311 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/DK00/00094	07/03/2000	08/03/1999
International Patent Classification (IPC) or national classification and IPC G01W1/00		
Applicant NIELSEN, Evan		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 11 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
02/10/2000	22.03.01
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kunz, L Telephone No. +49 89 2399 2628

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/DK00/00094

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1,5-21	as originally filed			
2-4,4a	as received on	22/02/2001	with letter of	19/02/2001

Claims, No.:

1-23	as received on	22/02/2001	with letter of	19/02/2001

Drawings, sheets:

1/8-5/8,7/8,8/8	as originally filed			
6/8	as received on	22/02/2001	with letter of	19/02/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:
   ☐ the claims, Nos.:
   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1 to 23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1 to 23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1 to 23
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

The following documents (D) cited in the International Search Report are refrrred to in this International Preliminary Examination Report.

D1 : US - A - 3 940 622
D2 : US - A - 5 317 915

V. Reasoned Statement with Respect to the Requirements of Article 33 PCT

Novelty: Document D1 describes an apparatus for determining an icing factor for atmospheric air containing supercooled water, wherein a flow of ambient air is created over a surface element for a predetermined period of time. The surface element is made of a material which is suitable for ice in atmospheric air to freeze on. The thickness of the ice cover is periodically measured whereupon the surface element is heated to remove the ice.
The subject matter of independent method claim 1 and independent apparatus claim 8 differs from this device known from document D1 in that the surface element is moved through the atmospheric air for a predetermined period of time and then, after the predetermined period of time, the thickness or mass of the ice frozen on the surface element is determined.
Inventive Step: If an air flow is created, the supercooled water tends to deposit on guiding elements for the air flow. This results in unpredictable influences on the air stream and can even lead to an interruption of the air flow. In order to avoid such problems, in document D1, the air flow is created by a heated primary gas through jet outlets arranged around the surface element. This heated primary gas, however, influences the temperature of the measured air flow with respect to the temperature of the ambient air. By simply moving the surface element through the ambient atmospheric air, all these problems are easily avoided.
Document D2 describes a helicopter including means for measuring the weight of the rotor during flight. Ice deposited on the rotor blades can thus be detected. Since measuring of the rotor weight for detecting icing only when the engine is stopped would lead to a crash, this document does not anticipate the claimed method and apparatus.
The combination of documents D1 and D2 is not obvious, because they concern completely different aspects of ice deposition warning.

Industrial Applicability: The claimed method / apparatus can be used e.g. on an airport for giving an indication of the risk of ice deposition from supercooled water in the air.

Dependent claims 2 to 7 concern additional method steps to the method defined in independent claim 1. Dependent claims 9 to 23 concern additional features to the apparatus defined in independent claim 8.
Therefore, the dependent claims also meet the requirements of Article 33 PCT with respect to novelty, inventive step and industrial applicability.

VII. Certain Defects in the International Application

The word "wherein" at the beginning of each method step in independent claim 1 (see lines 6, 12, 16 and 22) is unnecessary and should be deleted.

for carrying out a more standardised measurement of the amount of atmospheric precipitation.

Thus, US patent No 4,730,485 teaches a stationary measurement device configured for measuring wind velocity as well as wind direction, but it is also suitable for measurement of the current icing.

Published NO patent application No 151,060 discloses a stationary weighing apparatus for weighing an amount of atmospheric precipitation in the form of snow or ice that settles on a substantially horizontal weighing plate.

However, it is a problem in connection with these prior art devices that icing often occurs in situations when the air is relatively still, and that the icing factor measured by such devices are erroneous since only small amounts of ice are deposited on the devices.

It is a further problem in connection with the prior art device known from published NO patent application No 151,060 that atmospheric precipitation other than supercooled water may deposit on the weighing plate and thus an erroneous weighing results in relation to the icing factor.

US patent 3 940 622 discloses a detector for detecting the rate of ice-formation. In order to provide an instream of air, ambient air flow is created by inducing a primary gas into a duct, the primary gas being supplied, for example, by the engine compressor of a VTOL aircraft.

US patent 5 317 915 is concerned with the problem of detecting icing-up of a rotor of an aircraft. This known measuring device comprises means for determining an axial

load on the rotor axis under dynamic circumstances, i.e. during operation of the rotor.

It is therefore the object of the present invention to provide a method and an apparatus whereby it is possible, in almost all weather conditions, in particular also light winds and still air, to provide a standardised measurement result or a standardised value for the icing factor.

This is achieved with the present invention by the method according to claim 1, or by use of an apparatus according to claim 8.

The method according to the present invention thus comprises the following process steps, wherein at least one surface element is provided that is made of a material suitable for ice in atmospheric air to freeze on, said element having a predetermined surface area, wherein the surface element(s) is/are brought to a temperature that corresponds essentially to the temperature of the atmospheric air, wherein a relative movement at a predetermined velocity is subsequently created between the atmospheric air and the surface element(s) by allowing the surface element(s) to move through the atmospheric air, and for a predetermined period of time, and wherein the thickness or mass of the ice frozen fast to the surface element(s) is subsequently measured by means of a measurement device configured therefore after said predetermined period of time.

This means, on the one hand, that atmospheric precipitation other than supercooled raindrops or mist can only with difficulty settle on the surface elements and adversely influence the measurement results, and that it is

hereby possible to perform relatively accurate measurements of the icing factor, also in relatively still air.

In case the factor measured is the thickness of the ice layer, it is advantageous - to obtain a representative value therefore - to measure in a number of points, preferably in one or more points on each surface element, the measurement results subsequently being summarised to a single value.

The value thus measured for the thickness of ice layer or weight increase will be a standardised factor that indicates a relative risk of icing of eg aeroplanes or vessels in the area in which measurement is performed. It goes without saying that the value can only be indicative of the risk since, obviously, it will vary more or less compared to the place where the measurement was performed.

The method can advantageously be exercised by use of an apparatus as featured in claim 8, said apparatus comprising at least one surface element (3) made of a material suitable for ice in atmospheric air to freeze on, wherein the surface element(s) has/have a predetermined surface area, and wherein the apparatus further comprises means (4) configured for moving the surface element(s) through the atmospheric air at a predetermined rate and for a predetermined period of time, and wherein further means (5) are provided for measuring the thickness or mass of the ice frozen fast onto the surface element(s) after the predetermined period of time, during which the surface element(s) has/have been moved through the atmospheric air.

According to a preferred embodiment of the method, it is ensured that frozen-on ice, if any, is removed prior to a

first measurement, and likewise the frozen-on ice is removed from the individual surface element following measurement of its mass or thickness, whereupon a renewed measurement process can be performed. Advantageously, such removal of the ice can be accomplished by heating of

C l a i m s

1. A method for local measurement of an icing factor for atmospheric air containing supercooled water, the method comprising the following process steps:

wherein at least one surface element (3) is provided that is made of a material suitable for ice in atmospheric air to freeze on, said element having a predetermined surface area;

wherein the surface element(s) is/are brought to a temperature that corresponds essentially to the temperature of the atmospheric air;

wherein a relative movement at a predetermined velocity is subsequently created between the atmospheric air and the surface element(s) by allowing the surface element(s) to move through the atmospheric air, and for a predetermined period of time;

and wherein the thickness or mass of the ice frozen fast to the surface element(s) is subsequently measured by means of a measurement device configured therefore after said predetermined period of time.

2. A method according to claim 1, wherein the ice frozen fast is, following measurement its mass or thickness, removed from the surface element(s), whereupon a renewed measurement process can be performed.

3. A method according to claim 2, wherein the ice frozen fast is removed by heating of the surface element(s).

4. A method according to any one of the preceding claims, wherein a cover is provided that in a first position ex-

tends at least across the surface element(s), and covers and shields the surface element(s); and said cover being removed from the surface element(s) at least for the predetermined period of time during which the surface element(s) is/are moved through the atmospheric air at a predetermined rate.

5. A method according to claim 4, wherein the surface element(s) is/are caused to move for a predetermined period of time after the cover has reverted to its first position following a measurement procedure, whereupon the thickness or mass of the ice frozen fast on the surface element(s) is measured.

6. A method according to any one of the preceding claims, wherein the surface element(s) are caused to move through the atmospheric air at a velocity that ensures that atmospheric precipitation not frozen fast onto the surface element(s) is substantially thrown off the surface element(s).

7. A method according to any one of the preceding claims, wherein at least two surface elements are used that are rotatably arranged on a rotor shaft; and that the movement of the two surface elements is accomplished by a rotation of the rotor shaft.

8. An apparatus for local measurement of an icing factor for atmospheric air containing supercooled water, wherein the apparatus comprises at least a surface element (3) made of a material suitable for ice in atmospheric air to freeze on, wherein the surface element(s) has/have a predetermined surface area, and wherein the apparatus further comprises means (4) configured for moving the surface element(s) through the atmospheric air at a predetermined rate and for a predetermined period of time, and

wherein further means (5) are provided for measuring the thickness or mass of the ice frozen fast onto the surface element(s) after the predetermined period of time, during which the surface element(s) has/have been moved through the atmospheric air.

9. An apparatus according to claim 8, comprising a weighing device (5) configured for weighing and recording at least the weight of the surface element(s) before and after the surface element(s) is/are caused to move through the atmospheric air.

10. An apparatus according to claim 8 or 9, comprising means for heating the surface element(s).

11. An apparatus according to any one of claims 8 through 10, wherein the apparatus comprises a rotor element with a rotor shaft (2), and at least two surface elements (3) that extend from the rotor shaft and protrude there from, and wherein means (4) are provided for rotating the rotor abut its axis.

12. An apparatus according to any one of claims 8 through 11, wherein the apparatus comprises a cover (6) whose inside faces towards the surface elements and which is configured for occupying a first position in which it extends across the surface element(s) that is/are hereby covered upwardly, and a second position in which the cover is removed and does not cover the surface element(s).

13. An apparatus according to claim 12, wherein the cover is configured such that it forms, in its first position, a closed space (7) around the surface element(s).

14. An apparatus according to claim 13, wherein means (8,9) are provided for heating the closed space underneath the cover.

15. An apparatus according to any one of claims 12 through 14, wherein the apparatus is configured for moving the surface element(s) for a predetermined period of time after the cover (6) has, following a measurement procedure, reverted to its first position, whereupon the thickness or mass of ice frozen fast can be determined.

16. An apparatus according to any one of claims 12 through 15, wherein the cover is, in its second position, positioned such that its inside is substantially protected against atmospheric precipitation and consequently remains dry.

17. An apparatus according to any one of claims 8 through 16, wherein the surface element(s) each consists of a plate having a front (13) and a back (14) oriented opposite thereto, and wherein the plate is configured in such a manner that the front of the plate faces in the direction in which the respective surface element is moved through the atmospheric air, and wherein - through the plate - a plurality of passageways (10) extend from the front of the plate to its back such that the atmospheric air is allowed to flow through the passageways from the front of the plate to the back of the plate.

18. An apparatus according to any one of claims 8 through 17, wherein the apparatus comprises a system of surface elements (21,22,23,24) mounted on a rotatable shaft (20) configured for being positioned in an essentially vertical position; and wherein the individual surface elements are configured and arranged such that the individual surface elements, corresponding to their projection on a

face perpendicular to the rotatable shaft, abuts on or overlaps other surface elements, whereby it is accomplished that there is no space between the individual surface elements when the apparatus is viewed from above, and thus that all atmospheric precipitation falling within the expanse of the apparatus, when the rotatable shaft is positioned vertically, essentially hits the surface elements and is thus able to settle in the form of ice.

19. An apparatus according to claim 18, wherein the surface elements are configured and arranged such that the individual surface elements corresponding to their projection on a face parallel with the rotatable shaft (20) abuts on or overlaps other surface elements, whereby there is no space between the individual surface elements, when the apparatus is viewed from the side, and such that the atmospheric air conveyed across the surface elements in a direction substantially perpendicular to the shaft by a relative movement between the atmospheric air and the surface elements substantially hits a surface element and is thus able to deposit the water contained therein as ice.

20. An apparatus according to any one of claims 8 through 19, wherein the surface elements are configured with passageways; and that the apparatus comprises means such that air can be conveyed through the passageways.

21. An apparatus according to claim 20, wherein the apparatus comprises means for providing air in the form of either heated air or air essentially with ambient temperature.

22. An apparatus according to any one of claims 8 through 21, wherein the apparatus is arranged at ground level in

an airport; and that the apparatus comprises means for recording the measurement results for the thickness or mass of the ice deposited on the surface element(s), and means for visually or auditively emitting a signal to the monitoring personnel about the measurement result.

23. An apparatus according to claim 22, wherein the apparatus comprises means for converting the thickness or mass measured into a value that will be indicative of a risk of icing.

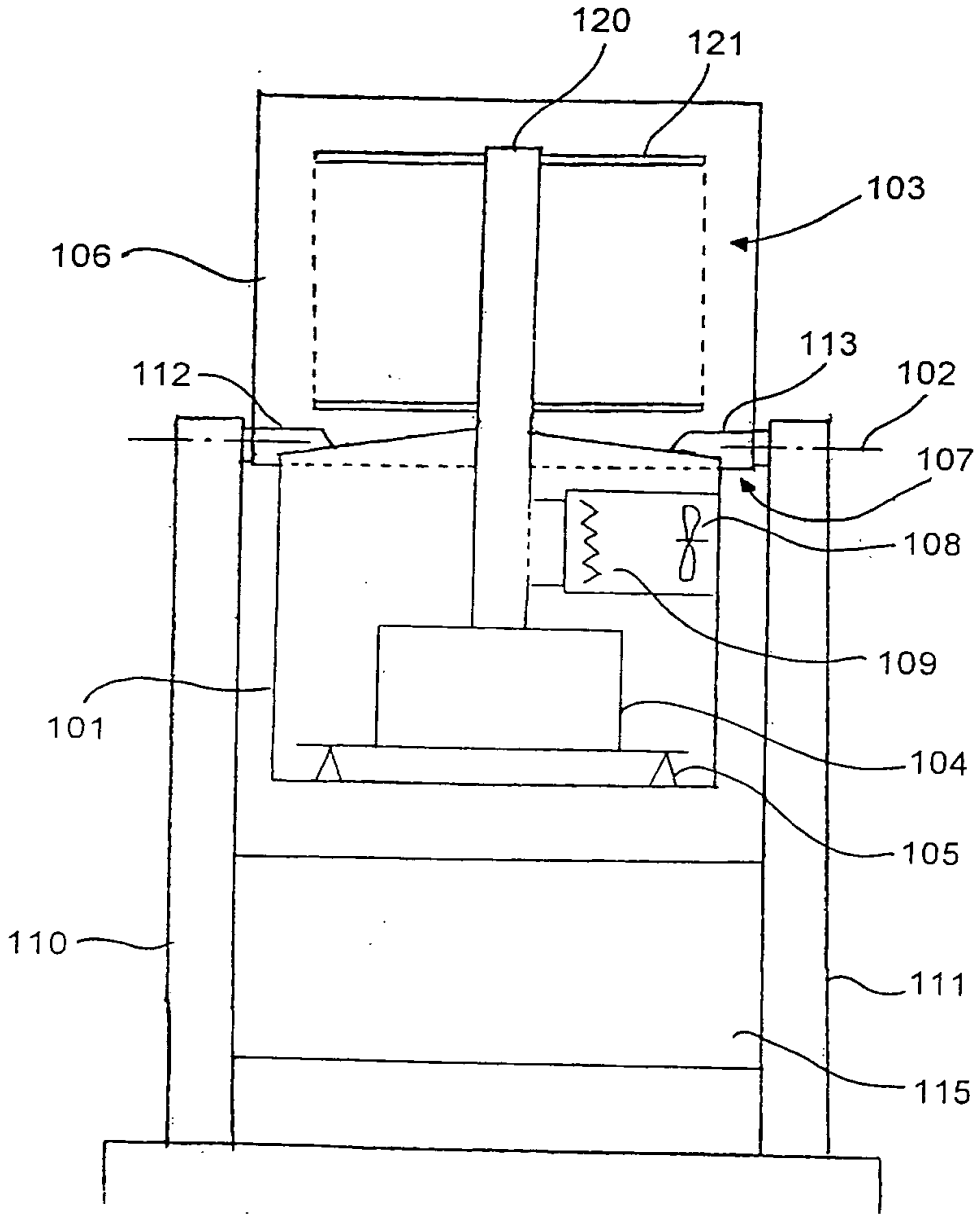


Fig. 10